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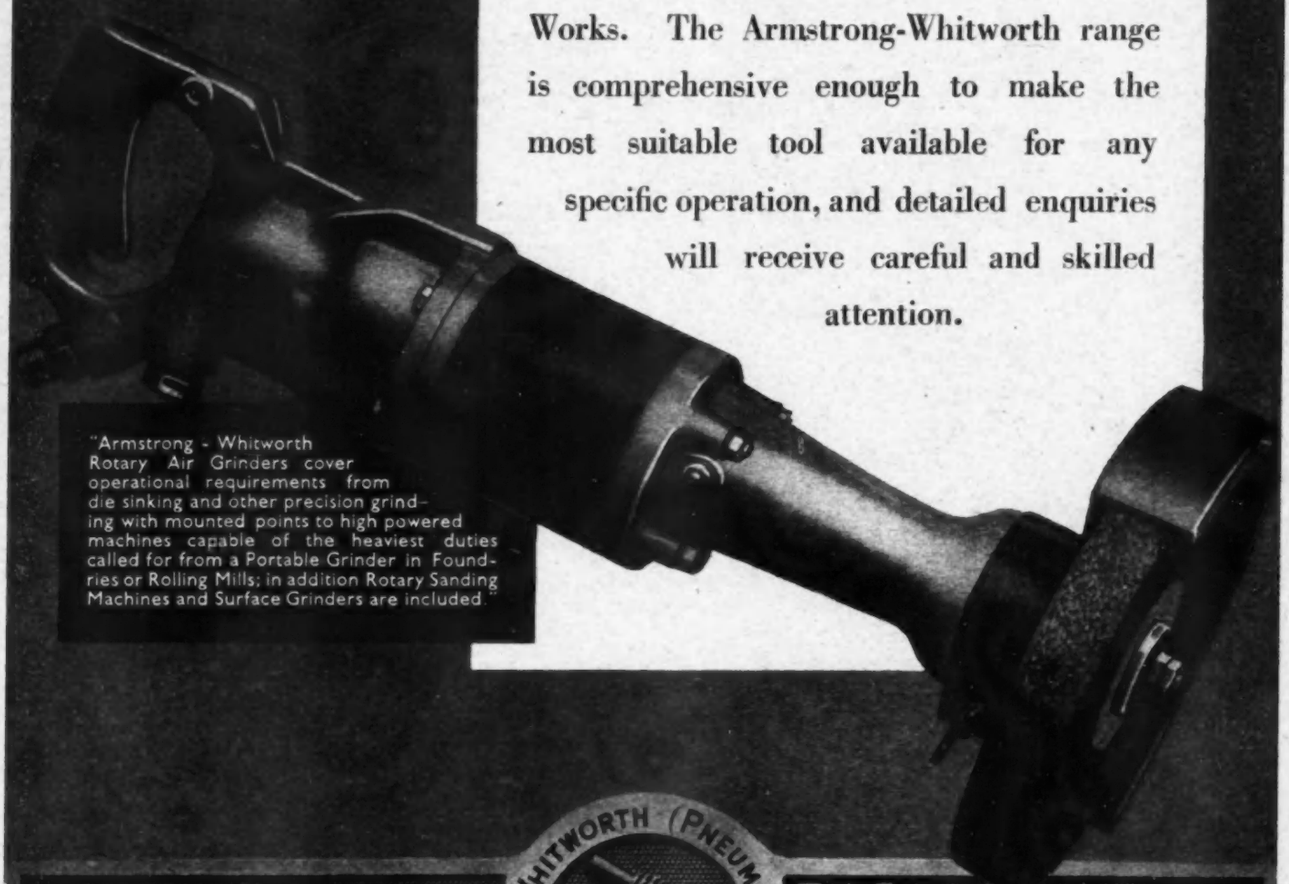

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THE TESTING OF DUST-EXTRACTION PLANT.

(*Continued from page* 423.)

SOME such considerations were among those that induced the Electricity Commissioners of Great Britain, in 1930, to appoint a committee under the chairmanship of Mr. C. D. Taite, to study the reduction of dust emission from power-station chimneys. It is remarkable that the committee's report* made reference to every one of the types of dust-extraction apparatus mentioned in Barkley's more recent paper, the developments during the intervening years being largely restricted to details of design or combinations of different types of plant. At the time when data for the report were being collected, extraction plants were installed at only 60 selected stations in this country. Of these, 53 were cyclone plants, while a further four were cyclones used in combination with washing devices. As is well known, the report emphasised the importance of standardising the methods of testing extraction plant and of grading the extracted particles. The committee urged that attention should be given to the problems of achieving an accurate system of testing under working conditions, and of developing a method of grading dust in terms of its rate of fall in still air. Grading in terms of particle size by means of sieves was stated to be unsatisfactory, especially in the case of dust smaller than about 40 microns, both on account of the unreliability of very fine-mesh sieves and of the fact that the important quality to be measured is the density of the dust rather than its size.

In response to these representations by the Electricity Commissioners, a Technical Committee of the British Standards Institution was appointed, in May, 1934, to study the question comprehensively in co-operation with a large number of scientific and industrial organisations represented on the Mechanical Industry Committee of the Institution. The outcome, six years later, is the publication of British Standard No. 893-1940 for *The Method of Testing Dust Extraction Plant and the Emission of Solids from Chimneys of Electric Power Stations.*† The standard is divided into three main parts, respectively devoted to the methods of testing, of sampling flue gases, and of air elutriation of flue dust.

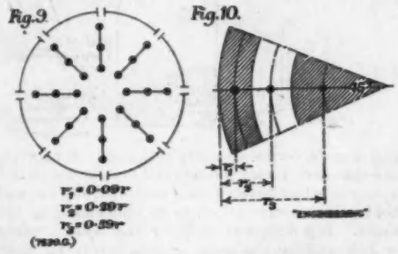
Part I, which limits the scope of the Standard to the testing of power-station chimneys, makes no distinction regarding the type of extraction plant, the implication being that the Standard is intended to be equally satisfactory for all types. The term "dust" is used to connote all solids in the flue gases, irrespective of size or composition, and thus embraces all terms, such as grit, fly-ash, and smoke, which have been used in the past without clear definition. The Standard requires the emission of solids to be expressed in grains per cubic foot of dry flue-gas at normal temperature and pressure, and also in pounds per hour, thus ensuring consideration for the interests both of the station engineer and of the public. It is noteworthy that gas sampling, to determine dust content, need be made only on the outlet side of the extraction plant, sampling of the gases entering an extractor being regarded as being, in most cases, too difficult for accurate results to be obtained. If the efficiency of the extractor is desired, it may be based on a measurement of the amount of dust collected during the sampling period, all boiler conditions being kept as constant as practicable and soot blowing avoided except by agreement among the parties to the test.

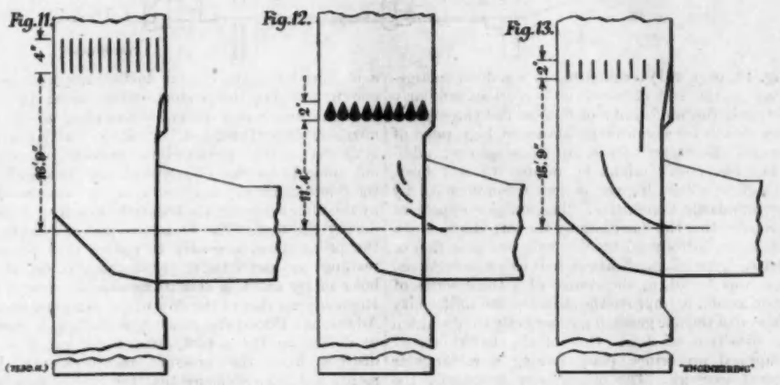
The determination of total dust concentration in the effluent gases, by withdrawing and filtering a representative sample, is to be carried out at a position (not necessarily in the chimney) where the gas flow is known to be reasonably uniform, and where the flue-gas velocity is, preferably, not less than 15 ft. per second. The recommended sampling apparatus consists, essentially, of an open-ended tube facing the direction of gas flow (within limits of 10 deg. error in yaw); a filter, to extract the dust from the sample, of such a size that the gas flow through the filtering medium does not exceed 15 ft. per minute; a meter to measure the volume of gas withdrawn and to keep the withdrawal velocity in the sampling tube within 10 per cent. of the velocity of the flue gas at the sampling position; and, finally, at the far end of this withdrawal line, a variable-speed exhauster. Provision is made, of course, for measurements of the pressure, temperature and humidity of the sample, while strict precautions are enjoined to guard against leaks. Over the cross-section of the flue under test, samples are to be taken from at least 24 points, corresponding to the centres of equal areas. Thus, a rectangular flue may be conveniently divided into a number of identical rectangles and samples taken at the geometrical centre of each. In the case of a flue of circular cross-section, the sampling points are arranged as indicated in Figs. 9 and 10, herewith, at equal angular intervals, and at radial distances from the centre, such that the points are at the centres of equal annular areas. Sampling must be continued for an equal length of time—not less than 10 minutes—at each point, and may be carried out by one sampling tube, moved in succession from one point to the next, or by several sampling tubes used simultaneously.

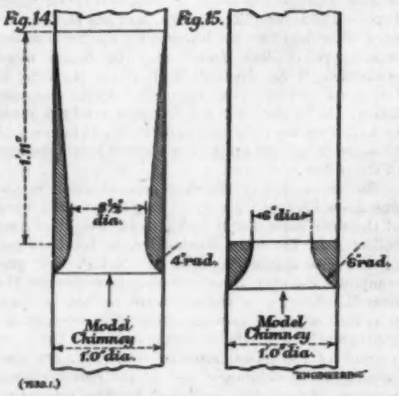
In all this procedure, the principal difficulty is to find a section of the flue across which the flow of gas is reasonably uniform. The endeavour to specify such a section led the Technical Committee to inaugurate a comprehensive programme of tests, which were carried out at the National Physical Laboratory,* and upon which extensive notes are included in Appendix D of the present British Standard No. 893. The importance of the matter derives from the fact that solid particles, on account of their inertia, are not uniformly distributed across any section of the gas stream, owing to the disturbing effects of the sharp bends that almost invariably occur in power-station flues. It is impracticable to induce sufficient turbulence in the gases to ensure even distribution of dust, and the alternative, adopted in the Standard, of sampling at a large number of points is at best an approximation and, by extending the length of time occupied by the tests, introduces difficulties in maintaining constant conditions of boiler and extractor operation. If accuracy is to be obtained by this method, it is essential that the flue-gases should have closely parallel flow at the sampling cross-section, besides having uniform distribution of velocity and dust concentration.

The experiments at the National Physical Laboratory were made with scale models of existing chimneys, embodying, in the first place, a simple arrangement of a horizontal flue leading into a vertical chimney. Figs. 11, 12 and 13, on this page, show how various systems of vanes, of gradually increasing elaboration, were introduced to assist the flow around the bend, valuable improvements in the uniformity of the flow above the breeching being eventually achieved. It is evident, however, that to produce an equivalent result in any particular existing plant would entail a lengthy and difficult investigation, although it is worth noting that the resistance to gas flow would almost certainly be reduced thereby, leading to a valuable augment of natural draught, and suggesting that there is scope for improvement in flue design from the aspect of fan power. But this aspect is a matter for consideration in the layout of new boiler plant. Regarded as merely incidental to the testing of dust-extraction apparatus, the guide vanes necessary to produce uniform flow are too costly and elaborate to be generally recommended at the present time, and may, in addition, lead to an undesirable accumulation of dust due to the introduction of the guide vanes themselves. Even when the guiding device takes the simplest form of a cellular arrangement or "honeycomb" of vanes, the improvement of flow, though measurable, depends upon the dimensions and position of the vanes, and does not, as a rule, justify the cost of installing them and of experimentally determining their optimum arrangement.

With these disadvantages of guide vanes in mind, the experimenters at the National Physical Laboratory explored the possibilities offered by fitting various forms of constriction in the chimney. A convergent-divergent nozzle (Fig. 14, herewith), gave better uniformity of direction and speed at its throat than was the case with the original chimney with practically no overall increase of flow resistance. A shorter convergent nozzle of severer contraction





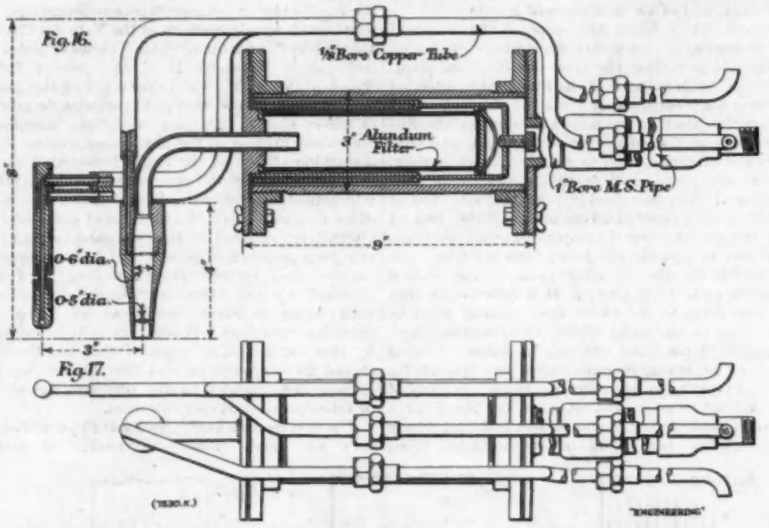


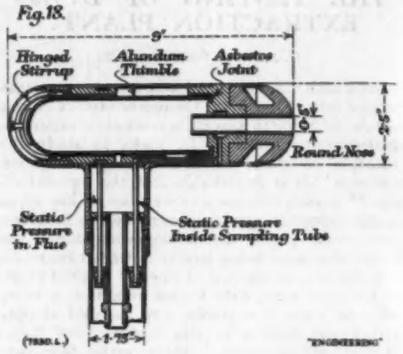
* "Report on the Measures which have been taken in this Country and in others to Obviate the Emission of Soot, Ash, Grit and Gritty Particles from the Chimneys of Electric Power Stations." London: H.M. Stationery Office (1932). See ENGINEERING, vol. 134, page 714 (1932).

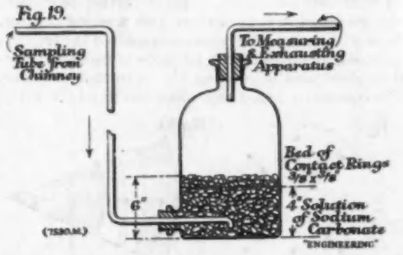
† Published by the British Standards Institution. [Price 5s. net.]

* N.P.L. *Annual Report*, 1935. See ENGINEERING, vol. 142, page 127 (1936).

TESTING OF DUST EXTRACTION PLANT.







(Fig. 13, page 461) terminating in a sudden enlargement to the full chimney cross-section, similarly increased the uniformity of flow at the throat, but gave rise to considerable resistance at high rates of flue-gas discharge. Since, in consequence, additional fan power might be needed to test dust-extraction plant, its use is not recommended by the Standards Committee. The simpler expedient of constricting the flue gases by the introduction of a flat baffle, introduced transversely across a flue or duct so as to blank off about half its cross-sectional area, was found, in the course of a third series of experiments, to improve the stability and uniformity of speed of the flue gases, if not perfectly to straighten the direction of flow. One of the baffles tested comprised an orifice plate having a rectangular central aperture. The others were practically the equivalents of half-closed transverse dampers, and the Committee suggest that a practical and inexpensive method of obtaining the type of flow necessary for effective dust sampling is to be sought in this direction. Under ideal conditions, of course, the obvious place to obtain parallel flow of gases in a flue is at the end of a straight length of ten or more diameters. In practice, such straight runs are seldom found except in a tall chimney, and if the flue enters the chimney at roof level the condition cannot be realised at all. If, therefore, really adequate straightening devices are not installed in the flue, the Committee recommend that dust sampling should be done at the maximum practicable height above the flue entrance. For completeness of the Standard Specification, they have fixed the minimum sampling height at (D + 5) ft. above the top of the flue, D being the diameter of the chimney in feet. This is a reluctant decision, since considerable variations of gas velocity and dust concentration are known to be possible so near the breeching, and the Committee wish it to be understood that this is a provisional specification which they are fully prepared to modify in the light of practical experience. Upon this subject, it is stated, they will be glad to receive information and opinions from those who make use of their tentative recommendation.

Another considerable Appendix to the Standard deals with recommended forms of sampling apparatus, the essential functions of which are to withdraw a truly representative sample of the dust-laden flue-gas, to permit the removal of the solid suspended matter, and to enable the quantities of dust and gas to be separately measured. For the latter purpose, the temperature, pressure and humidity of the gas must be determined at the point where its volume is measured. The recommended sampling nozzle may be either feather-edged, as in Figs. 16 and 17, on this page, or hemispherically-ended, as in Fig. 18, also on this page; preferably not less than ½-in. in internal diameter, and made (like other parts of the sampling equipment in contact with unfiltered gases) of material resistant to sulphuric acid, in order to prevent the dust sample from being contaminated by the products of corrosion. In some of the recommended designs of sampling nozzle, the nozzle itself is "furnished" or "fitted" with internal and external static-pressure holes, providing a continuous guide to the rate of sampling, and thus enabling the fluctuations of gas velocity, or variations caused by the filter becoming choked, to be rapidly corrected during the test. The Standard provides notes on the precautions necessary to ensure that pressure readings are not vitiated by stoppage of the static holes or by unstable conditions associated with the Reynolds number of the flow in the sampling nozzle. Additional Pitot-tube measurements are necessary to determine the actual rate of flue-gas flow, as distinct from the pressure measurements, just mentioned, which ensure that the rate of flow into the sampling nozzle is maintained equal to that of the surrounding gases passing along the duct or chimney. The most attractive designs of nozzle, in this respect, embody a Pitot-static tube, either within, as in Figs. 16 and 17, or, as in Fig. 18, alongside the sampling tube—an arrangement which promises less uncertainty than the alternative of a previous separate Pitot exploration over the cross-section of the duct.

Differences in the constitution of the dust, according to the nature of the combustion, are reflected in the types of filter recommended for sampling the cleaned flue gases from stoker-fired and from pulverised-fuel boilers. It has been found that, owing to the presence of sulphur-trioxide in the flue gases from stoker-fired boilers, dry filtering media such as woollen fabrics, alundum, (a refractory form of fused bauxite) or paper, give unsatisfactory results and involve elaborate chemical analysis. A less complicated method is to scrub the gases with an alkaline solution. For example, as shown in Fig. 19, herewith, the gas may be passed continuously through a bed of porcelain contact rings in a glass bottle partly full of sodium-carbonate solution—a form of scrubber which can be also used quite satisfactorily for pulverised-fuel gases and has the incidental advantage of maintaining a low and constant pressure drop in the sampling system throughout a test. The dry filters which can be used with pulverised-fuel installations make, of course, a more compact and less fragile sampling device; and, since they are commonly of a thimble type, embodied in the sampling head, no dust is deposited in the tube connecting the nozzle and the filter. If the filter is not surrounded by the flue gases being tested, the filter and its connecting tube should be heated by a jacket to the temperature of the flue gas in order to prevent condensation. Since the pressure drop across an alundum filter is large at the rates of sampling flow desired, the exhauster employed must be capable of producing a much greater suction than is needed for fabric filters and precautions against leaks in the sampling line must be correspondingly stringent. For service as exhausters, rotary blowers and fans, steam, water and air ejectors have all been used with success, and no particular stipulations or recommendations are made. It is remarked, however, that while a rotary or bellows-type gas meter is satisfactory for most types of ½-in. sampling nozzles, and has the advantage of embodying an integrating mechanism, an orifice-type of flow meter may be found more convenient if the pressure drop across the filter is large—as occurs, for example, with alundum filters. With such meters, frequent readings must be taken during each test and the temperature and pressure of the gas must be measured just upstream of the orifice.

The expression of the dust concentration in the flue gases leaving the extraction plant, in the form of the ratio represented by the total weight of dust collected by the filter divided by the total volume of the gas sample reduced to N.T.P. dry gas, completes the operations necessary to determine the overall efficiency of the extractor on the assumption that separate measurements have been made, concurrently with the sampling tests, of the total volume of the gases, reduced to N.T.P. dry gas, passing up the chimney, and of the corresponding total weight of dust collected by the separating plant. It may be noted that the total gas volume may be calculated from an adequate number of Pitot-tube readings taken at the sampling section, but that the Standard recommends that this volume should preferably be made from the analysis of the flue gas at the sampling section, in conjunction with analyses of the coal and of the carbon in the ash, and the measured rate of coal consumption.

(To be continued.)

THE INSTITUTE OF PHYSICS.—At the annual general meeting of the Institute of Physics, held on June 4, Professor Sir Lawrence Bragg, F.R.S., was elected President; Professor W. Makower, vice-president; Major C. E. J. Phillips, honorary treasurer; and Professor J. A. Crowther, honorary secretary. Two ordinary members of the board were also elected, namely, Professor J. Chadwick and Mr. D. C. Gall. All these gentlemen will take office on October 1.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—The Council of the Institution of Electrical Engineers have nominated Sir Noel Ashbridge, B.Sc.(Eng.), to be President; Professor S. Parker Smith, D.Sc., to be vice-president; Mr. E. Leete to be honorary treasurer, and Lieut.-Col. S. E. Monkhouse, Mr. E. Parkinson and Mr. S. E. Goodall, M.Sc.(Eng.), (associate member of the Institution) to be ordinary members of the council. The nominations are to fill vacancies which will occur on September 30 next.

LITERATURE.

Applied X-Rays. Third edition. By PROFESSOR GEORGE L. CLARK. London: McGraw-Hill Publishing Company, Limited. [Price 42s.]

THE third edition of Professor Clark's well-known work on X-rays, originally published in 1927, has been considerably expanded to keep pace with the phenomenal growth of the subject. The first third of the book is devoted to the general physics and applications of X-radiation. An account of the evolution of the X-ray tube from the original pattern of Röntgen to the modern types, affording independent control of intensity and quality, is followed by a description of the equipment devised to supply the progressively higher voltages demanded. The various methods of measuring the intensity and wavelength of the X-radiation are described. A helpful survey of X-ray spectra in relation to atomic structure is given, and the advantages and disadvantages of methods of chemical analysis based on X-ray spectroscopy are clearly brought out in the book.

The absorption and scattering of X-rays by matter has been extensively studied since Röntgen's time, and, as differential absorption by heterogeneous materials of varying density forms the basis of radiography, such studies are of great practical importance. The use of radiographs in medical diagnosis is firmly established. Their employment in such diverse fields as the routine examination of castings and of citrus fruits, and checks upon the authenticity of paintings attributed to old masters, is becoming more widely appreciated. This first part concludes with an account of the biological effects of X-radiation, due stress being laid on the protection of the operator of the plant.

Part II, which occupies the remaining two-thirds of the book, deals with the X-ray analysis of the ultimate structures of materials. The central facts in this connection are, firstly, that the structural units within a crystal form an ordered three-dimensional array, and, secondly, that the wavelengths of the X-rays are of the same order of magnitude as the distances separating these structural units within the crystal lattice. The influence of structure upon properties is well brought out by the fact that a single substance (carbon) can, in different atomic arrangements, behave either as an abrasive (diamond) or as a lubricant (graphite). A sketch of the fundamental concepts of geometrical crystallography serves to introduce the various techniques employed in the X-ray analysis of crystals. These usually result in the recording of a pattern of lines or spots on a photographic film, and the methods whereby such patterns can be made to yield information concerning the structure of the crystals concerned is next outlined. The results of crystal analyses, both of inorganic or organic compounds, are reviewed, many of the latest results being collected together in tabular form in order to facilitate reference.

X-ray metallography is well treated. The crystalline structure of pure metals is discussed, together with the present status of X-ray research into the structure of alloys. The manner in which such features as grain size, internal strain and the effects of mechanical deformation modify the diffraction patterns is also considered. The remaining chapters deal with the structure of glasses, liquids and colloidal materials and the recent work on polymers —synthetic and natural materials with giant molecules. An error occurs on page 109 in the statement that the wave number is the frequency divided by the Rydberg constant. The meaning of the expression "to key slip" on page 409 is not obvious, and the "denier" (page 605) is a sufficiently unfamiliar unit to merit definition.

Very little of interest has escaped Professor Clark's attention, and his whole treatment is right up to date, references to work published in 1939 being included. In a few places only has a desire to include too much reduced what is said below the limits of usefulness. As a broad survey, however, this very readable book is probably unsurpassed, and few actual or potential users of X-rays will fail to derive stimulus and guidance from its pages. A word of special praise must be written regarding the many excellently reproduced illustrations which are a credit to all concerned with the production of the book.

The Aviation Mechanic. By C. NORCROSS and J. D. QUINN. London: McGraw-Hill Publishing Company, Limited. [Price 21s. net.]

THIS is an American book, written in a style seldom seen in the technical literature of this country. It is intended to be a text-book upon the work of an aeroplane or aero-engine mechanic, but so emphasises the psychological outlook of the necessity for conscientiousness and integrity in his work, because of the complete catastrophe that might follow the lack of it, that the reader may wonder whether such characteristics are uncommon among American engineering mechanics, and whether the system of inspection of their work in the United States is either not so elaborate or not so efficient as is customary in this country. The combination of two authors, one a practical mechanic who has since taking up training of air mechanics professionally, and the other an organiser of the teaching and training of factory personnel, gives a total of experience which could hardly be bettered for a book of this class.

The arrangement of the book is logical. It commences with an elementary discussion of the principles of flight, structural construction, and design, sufficient to give the reader an insight into the main portion of the work that follows. The second part deals with the construction and building of an aeroplane, and gives very necessary distinct chapters on the problems from the points of view of small-scale and large factory mass production. This is followed by a third section dealing with maintenance and repair, subdivided into parts dealing with the different outlooks of the civil air-line operator and the fighting services repair section. Incidentally, this latter section has no counterpart in this country; the process of maintenance and repair of the R.A.F. machines, being of a confidential nature, is not made public.

The chapters dealing with construction are full and well illustrated, but are inclined to be patchy. In some cases, as, for instance, the process of fabric-covering a plane, the instructions are extremely detailed and the explanatory diagrams excellent. A beginner could take these and proceed step by step to carry out the job. Other classes of work, such as press-tool work for the making of metal parts, are dealt with by little more than illustrations of typical presses with a short and very insufficient description of the job on the press. Certainly there is not sufficient text here to enable the aspiring mechanic to do much useful work. The authors mention a Chinese proverb that "one picture is worth 10,000 words," but are sometimes inclined to overwork the principle in this part of the book, many pages being nothing more than pictures of machine tools and workshop equipment, with descriptive captions. The criticism applies particularly to the chapter on large factory production.

The third section, dealing with maintenance and repair, is much better, and deals with the subject in a very detailed and thorough manner. It is naturally based on methods that are compulsory by airworthiness regulations in the United States, which are not always the same as those in force in this country, and it should be read with discretion in this respect. It also makes constant reference by name only to proprietary articles, both tools and materials, which is confusing to an English reader, as many of the terms are unknown here. What, for instance, are a "pinch dog," a "shrink scale" and a "spin-tight socket wrench"?

Taken altogether, however, this is a book that might repay study by any beginner in the field of aircraft building and maintenance. It presents a point of view which is quite different from, and much more thorough than, that often given to the young apprentice in this country, and if it succeeds in inculcating in turn a spirit of conscientiousness and a desire to understand the principles underlying his work, reading it will have served a useful purpose, additional to the technical knowledge that he will have gained in the course of his study.

A THEORY OF THE KADENACY SYSTEM.

By E. W. GEYER, B.Sc., Ph.D.

A CONSIDERABLE amount of discussion regarding the Kadenacy system of exhausting gases from an internal-combustion engine cylinder has appeared in the correspondence columns of ENGINEERING, but it is somewhat surprising that no effort has been made by any of the investigators to place the matter on a rational basis.* It is hoped, therefore, that the following treatment may prove of general interest.

Consider the vessel A E F D, Fig. 1, page 464, having the internal capacity V cub. ft. and containing W lb. of gas at the absolute pressure p_1 and absolute temperature T_1. If the cover on the nozzle face G H is suddenly removed, the gas pressure in the vessel rapidly drops to that of the space beyond the nozzle and will, under certain conditions, drop below this value. At the instant when the pressure in the vessel is equal to the external pressure p_b let the mass of gas in the vessel be W_1 lb. and let the mass of gas which has escaped from the vessel be W_2 lb., *i.e.*, $W_1+W_2=W$. If the space A B C D contained the mass W_1 lb. of gas before discharge occurred, then the space B E F C contained W_2 lb. of gas and at the instant of equalisation of pressure the face B C will have arrived at the nozzle entrance. Let its approach velocity there be V_1 ft. per second. Since the velocity of the gas at A D is zero, the kinetic energy of the gas in the vessel is $\frac{1}{3}\frac{W_1 V_1^2}{2g}$. This is based on the assumption of a uniform increase in velocity from one end of the cylinder to the other.

If the cross-sectional areas of the vessel and nozzle are A_1 and A_2, the velocity of the gases leaving the nozzle is given by $V_2 = \frac{V_1 A_1}{A_2}$. This follows since the pressure at the nozzle exit and the pressure in the vessel are equal and hence the specific volumes in these regions are equal. The gases which have left the vessel may be assumed to occupy the imaginary cylinder shown in dotted outline as an extension on the right of the vessel. These gases have pushed the imaginary piston G H, on the outer side of which the constant pressure p_b acts, to the position K L, and at this instant the static pressure within the vessel equals p_b. The decrease in internal energy is given by $J W c_v (T_1 - T_2)$, where $T_2 = T_1 \left(\frac{p_b}{p_1}\right)^{\frac{\gamma-1}{\gamma}}$. This assumes isentropic expansion throughout. The work which has been performed so far against the external pressure is $144\, p_b\, W_2\, v_2$, where v_2 is the specific volume of the gas after expansion to p_b and is given by the relationship $v_2 = \frac{R T_2}{144\, p_2}$. The kinetic energy of the gas which has escaped from the cylinder is given, to a first approximation, by

$$\frac{W_2 V_2^2}{2g} = \frac{W_2}{2g}\left(\frac{A_1 V_1}{A_2}\right)^2.$$

so that the total kinetic energy given to the gas is

$$\frac{1}{3}\frac{W_1 V_1^2}{2g} + \frac{W_2}{2g}\left(\frac{A_1 V_1}{A_2}\right)^2.$$

We thus have

$$J W c_v (T_1 - T_2) = 144\, p_b\, v_2\, W_2 + \frac{V_1^2}{2g}\left\{\frac{1}{3} W_1 + W_2 \left(\frac{A_1}{A_2}\right)^2\right\} \quad . \quad . \quad (1)$$

From this expression, the value of V_2 can be calculated. Due to the kinetic energy of the gases in the vessel and the additional kinetic energy of the mass of gas which occupies the nozzle or any actual extension of the vessel, further work can be performed against the external pressure p_b. If W_3 be the weight of gas contained in the nozzle or in any extension, the work which can be performed

* This article was received at about the same time as that of Dr. E. Giffen, which was published in our 150th volume (1940), on pages 134, *et seq.*, but the publication of Dr. Geyer's article was delayed owing to circumstances arising out of the war.—ED., E.

against p_b is

$$\frac{1}{3}\frac{W_1 V_1^2}{2g} + \frac{W_2 V_2^2}{2g}, \quad . \quad . \quad (2)$$

and this equals $144\,p_b\,V$, where V is the increase in volume of the gas beyond the face G H. On the assumption that this expansion is adiabatic, we have the relationship

$$p_b\,(V')^\gamma = p\,(V'+V)^\gamma \quad . \quad . \quad (3)$$

where V′ is the volume of the vessel and the nozzle. The value $p_b - p$ is the attainable depression in the vessel under ideal conditions. The effect of a cylindrical extension, such as an exhaust pipe, to the vessel is to increase this depression as shown by the second term of the expression given above for the additional work performed against p_b, *i.e.*, by the expression $\frac{W_2 V_2^2}{2g}$.

From the data provided by the tests of Professor Davies, as described in the issue of ENGINEERING for January 5, 1940, page 17, the depression for the case in which the initial pressure is 60 lb. per square inch is found by means of the above treatment as follows: Assuming that the initial temperature in the vessel is 65 deg. F., and that the atmospheric pressure is 14·7 lb. per square inch, the initial absolute values of the temperature and pressure are $T_2 = 525$ deg. F. abs. and $p_1 = 14{\cdot}7 + 60 = 74{\cdot}7$ lb. per square inch abs. The temperature after expansion to $p_b = 14{\cdot}7$ lb. per square inch abs. is $T_1 = T_2\left(\frac{p_b}{p_1}\right)^{\frac{\gamma-1}{\gamma}} = 525 \div \left(\frac{74{\cdot}7}{14{\cdot}7}\right)^{\frac{0{\cdot}4}{1{\cdot}4}} = 330$ deg. F. abs. The initial weight of air in the vessel is $W = 144\,\frac{p_1 V}{R\,T_1} = 144 \times 74{\cdot}7 \times \frac{0{\cdot}0945}{53{\cdot}3} \times 330 = 0{\cdot}0363$ lb. The weight of air in the vessel when the pressure drops to 14·7 lb. per square inch abs. is $W_1 = 144 \times 14{\cdot}7 \times \frac{0{\cdot}0945}{53{\cdot}3} \times 330 = 0{\cdot}0114$ lb., and at this instant the specific volume is $v_2 = \frac{R\,T_2}{144\,p_b} = \frac{53{\cdot}3 \times 330}{144 \times 14{\cdot}7} = 8{\cdot}33$ cub. ft. per lb. The weight of air discharged up to this instant is $W_2 = W - W_1 = 0{\cdot}0363 - 0{\cdot}0114 = 0{\cdot}0249$ lb. The ratio $\frac{A_1}{A_2} = \left(\frac{4}{3{\cdot}625}\right)^2 = 1{\cdot}22$, so that $\left(\frac{A_1}{A_2}\right)^2 = 1{\cdot}49$. Equation (1) thus gives

$$\frac{V_1^2}{2g} = [778 \times 0{\cdot}0363 \times 0{\cdot}169\,(525 - 330) - 144 \times 14{\cdot}7 \times 8{\cdot}33 \times 0{\cdot}0249] \div (\tfrac{1}{3} \times 0{\cdot}0114 + 0{\cdot}0249 \times 1{\cdot}49)$$

$$= \frac{930 - 439}{0{\cdot}0408} = \frac{491}{0{\cdot}0408} = 12{,}050 \text{ ft.-lb.}$$

In the vessel used by Professor Davies the length of the parallel portion at outlet is $\frac{3}{4}$ in. and the weight of air contained in this, when the pressure becomes 14·7 lb. per square inch abs., is

$$W_2 = \frac{\pi \times 3{\cdot}6252 \times 0{\cdot}75}{4 \times 1{,}728 \times 8{\cdot}33} = 0{\cdot}000537 \text{ lb.}$$

Hence from equation (2) the available energy for the performance of work against p_b is $12{,}050\,(0{\cdot}0038 + 1{\cdot}49 \times 0{\cdot}000537) = 52{\cdot}2$ ft.-lb. The increase in volume of the gas beyond the nozzle exit is, therefore, $V = \frac{52{\cdot}2}{144 \times 14{\cdot}7} = 0{\cdot}0247$ cub. ft. Equation (3) gives $p = \frac{14{\cdot}7}{(0{\cdot}1192/0{\cdot}0945)^{1{\cdot}4}} = 10{\cdot}6$ lb. per square inch abs., so that the depression in the vessel is $14{\cdot}7 - 10{\cdot}6 = 4{\cdot}1$ lb. per square inch abs. Without the $\frac{3}{4}$-in. cylindrical extension the available energy is $12{,}050 \times 0{\cdot}0038 = 45{\cdot}7$ ft.-lb. and $V = \frac{45{\cdot}7}{144 \times 14{\cdot}7} = 0{\cdot}0216$ cub. ft. This gives $p = 14{\cdot}7 \div \left(\frac{0{\cdot}1161}{0{\cdot}0945}\right)^{1{\cdot}4} = 11$ lb. per square inch abs., so that the depression in the vessel is $14{\cdot}7 - 11{\cdot}0 = 3{\cdot}7$ lb. per square inch. Similar calculations have been carried out for initial pressures of 10, 20, 30, 40 and 50 lb. per square inch, and the results are shown in Table I.

Professor Davies shows from his test results that the depression is not uniform throughout the vessel. Let the variation in pressure be represented by the curve A B in Fig. 2. If the vessel could be closed suddenly the resulting uniform depression which would be attained in the vessel would be represented by O C where the area O C D E is equal to the area O A B E. From the curve given by Professor Davies in his article it is found that the mean uniform depression is 0·69 of the maximum depression. His maximum depressions, given in Fig. 4 of his article, have therefore been multiplied by this factor in order that a comparison may be made between his measured values and the values obtained by calculation. These are given in Table I, below. The calculated results, along with those given by Professor Davies from his tests, have been plotted in Fig. 3.

Fig. 1.

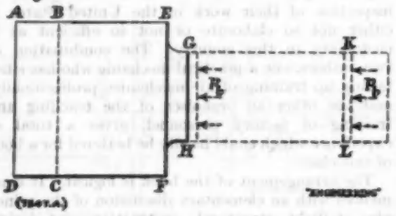


Fig. 2.

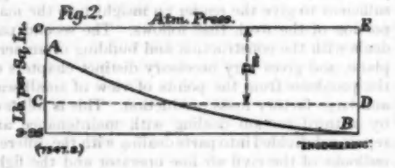
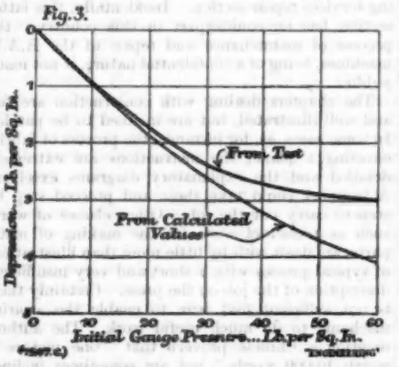


Fig. 3.



It will be seen from equation (1) that when, as is the case in practice, the outlet area is considerably less than the cross sectional area of the vessel, the available energy causing the depression is considerably reduced. Thus, in the example worked out in detail above, if $\frac{A_2}{A_1}$ is taken as $\frac{1}{6}$ in place of $\frac{1}{1{\cdot}22}$, equation (1) gives

$$\frac{V_1^2}{2g} = [778 \times 0{\cdot}0363 \times 0{\cdot}169\,(525 - 330) - 144 \times 14{\cdot}7 \times 8{\cdot}33 \times 0{\cdot}0249] \div (\tfrac{1}{6} \times 0{\cdot}0114 + 0{\cdot}0249 \times 36)$$

$$= 546 \text{ ft.-lb.}$$

The available kinetic energy from the gas in the vessel is thus $546 \times 0{\cdot}0038 = 2{\cdot}08$ ft.-lb., so that $V = \frac{2{\cdot}08}{144 \times 14{\cdot}7} = 0{\cdot}000983$ cub. ft. This gives $p = 14{\cdot}7 \div \left(\frac{0{\cdot}0955}{0{\cdot}0945}\right)^{1{\cdot}4} = \frac{14{\cdot}7}{1{\cdot}014} = 14{\cdot}5$ lb. per square inch abs. The depression is thus only 0·2 lb. per square inch. It seems clear that unless the area at outlet is a considerable fraction of the cross-sectional area of the vessel the depressions obtained are negligibly small. The implication is, therefore, that unless care is taken to provide a relatively large discharge area, a system depending on such depressions is likely to be inoperative.

TABLE I.

Initial Gauge Pressures, lb. per sq. in.		10	20	30	40	50	60
Depressions in lb. per sq. in.	Without extension	0·8	1·5	2·3	2·8	3·3	3·7
	With ¾ in. extension	1·0	1·8	2·6	3·2	3·7	4·1
Adjusted depressions from Professor Davies' tests		0·99	1·69	2·42	2·72	2·90	3·04

UTILISATION OF MANGANESE IN THE UNITED STATES STEEL INDUSTRY.*

By B. A. ROGERS.

THE problem of obtaining enough manganese for use in the manufacture of steel appears likely to recur when international relationships are disturbed and to become serious at any time when the United States is cut off from its customary supply. This state of affairs arises because, in normal times, it is economically advantageous to import into the United States available high-grade foreign ores and to neglect her own less satisfactory resources. That considerable low-grade manganese ore and a much smaller amount of high-grade material are available in the United States is well known from geological surveys and has been confirmed by Bureau of Mines investigations. The possibility of greatly expanding home production was actually demonstrated from 1913 to 1918, when the annual production of manganese from United States ores rose from about 4 per cent. to approximately 35 per cent. of the total consumption of ferromanganese and spiegeleisen. Assuming that it is possible to increase the production of manganese ores sufficiently to supply all American needs, such a programme presumably would require two or three years, and the cost of production would certainly rise considerably, for some time at least. For these reasons, it has become important to conserve manganese, and the suggestions that have been made for reducing the amount required may well be reviewed.

Manganese is used in steel for two reasons:—Firstly, because of its favourable effect on workability, and secondly, on account of its ability to improve the product. The beneficial effect of manganese in the reduction of ingots to the desired shape is well known, and the general reasons for this are fairly well agreed upon, although there is some controversy as to details. The action of manganese in removing the sulphur from ferrous sulphide to form manganous sulphide appears to be of major importance. The nature of the first of these sulphides is such that at a certain stage during cooling it works out between the grains of the steel and surrounds them with thin, low-melting envelopes of iron sulphide; whereas manganous sulphide agglomerates into small globules dispersed throughout the metal. A piece of steel which contains iron sulphide tends to fall apart during forging on account of the lack of cohesion between the grains of the metal, whereas one in which the sulphur is present as manganese sulphide does not exhibit this undesirable behaviour. The above statement does not completely explain why manganese eliminates the hot shortness of steel and permits it to be rolled without difficulty. There is little doubt that the amount of oxygen present also has an effect, and some investigators, particularly in Germany, consider it to be the major influence. A recent rather comprehensive experimental investigation and analysis of published data by F. G. Norris† resulted in the conclusion that a steel in which the percentages of manganese and sulphur are such that the ratio

$$\frac{Mn + 0{\cdot}048}{S + 0{\cdot}130}$$

is greater than 6·63 is never red-short; if this ratio is less than 3·30, the sample is always red-short; and if its value is intermediate the heat treatment of the sample determines the existence of the red-short condition. In this expression the chemical symbols represent the weight percentages of the corresponding elements.

The second reason for using manganese obviously refers to its employment as an alloying element. Manganese is commonly used in steels to impart certain properties desired by the fabricator or the ultimate consumer, but the product is not considered an alloy

* United States Bureau of Mines Information Circular 7162. Abridged.

† See "Factors Affecting Red-Shortness," *Jl. Iron and Steel Inst.*, vol. 138, page 75P (1938).

steel until the content of this element reaches 1·65 per cent. An example of such use is the addition to low-carbon sheet steel of 0·20 per cent. more manganese than the 0·15 per cent. to 0·20 per cent. required to ensure good behaviour in rolling. The additional amount eliminates the likelihood of the so-called "orange-peel" surface effect after a drawing operation and thus improves the quality of the finished product. The two reasons outlined—to insure proper ductility under hot working at all temperatures and to improve the character of the steel for specific purposes—constitute the arguments for using manganese. They are not the only reasons, however, as the presence of manganese oxide in the furnace slag must be considered during melting operations. On account of the lack of agreement concerning the function of manganese in the furnace, however, this matter will not be considered further.

Consumption of Manganese.—The total consumption of manganese in the United States steel industry can be estimated reasonably well, but the knowledge of the amounts consumed in the various ferrous products is less accurate. It is particularly difficult to specify how much material is used to make rolling possible and how much is employed to improve the character of plain carbon steels. A rough idea may be gained by noting the approximate amount of manganese used in all classes of steel and arbitrarily assigning some fraction as being essential to ensure proper rolling characteristics. Probably because manganese is added, so often, in greater quantities than will just suffice to ensure suitable working properties in the manufacturer's plant, little information is available as to the minimum amount necessary for this purpose. Furthermore, the percentage is not the same in all plants. A modern rolling mill with highly efficient heating equipment can roll material containing slightly less manganese, other factors remaining the same, than can be handled at an older type of mill having poor heating arrangements. As the present problem primarily concerns the consumption of manganese-containing addition substances, estimates of amounts used will refer only to the manganese added at the end of the heat.

A rimming steel may be rolled consistently if it contains 0·18 per cent. of manganese, or perhaps even a little less in some cases. Since the residual manganese in a heat of such steel may be approximately 0·10 per cent., probably 0·08 per cent. must be added as a minimum. On the other hand, for some types of killed steels the addition of 0·25 per cent. of manganese above the residual amount may be desirable. For all classes of steel an average (which, it should be emphasised, is only a very rough estimate) of 0·15 per cent. will be assumed. In 1937 the total output of steel ingots was slightly more than 50,000,000 gross tons. In view of the above assumptions, a round number is accurate enough for the purpose, and on this basis, 75,000 tons of manganese were required to make this quantity of steel workable. The total amount of manganese consumed in the form of ferro-manganese and spiegeleisen in 1937 was, in round numbers, 350,000 long tons, of which approximately 220,000 tons was furnished by ferro-manganese and the remainder by spiegeleisen. The assumption of an average loss of 25 per cent. in making the additions indicates that about 365,000 tons of manganese actually entered the steel. Of this total amount, about 75,000 tons, or about 28 per cent., were used in making the steel workable. If this conclusion is put in round numbers, the analysis indicates that somewhat less than one-third of the manganese is used for the benefit of the producer of steel and a little more than two-thirds in improving the character of the steel for the benefit of the user. Relatively little manganese is consumed in products classed as alloys. In this group may be put, besides the steels containing more than 1·65 per cent. manganese, the Hadfield steels (11 per cent. to 14 per cent. manganese) and cast steels and cast irons containing added manganese. This group is not large and for practical purposes may be ignored, as it probably does not consume more than 4 per cent. or 5 per cent. of the manganese used in the steel industry. The consumption of manganese in Hadfield steels, for example, may not have exceeded 5,000 tons in 1939.

Various manganese products are available for use in deoxidation work. For conciseness, these are listed below in the order of their manganese content:—(1) Electrolytic manganese and manganese metal (95 per cent. to 98 per cent. manganese); (2) ferro-manganese (and silico-manganese); (3) spiegeleisen (and silico-spiegel); and (4) manganiferous pig iron. Electrolytic manganese is a recent product with an actual manganese content probably in excess of 99·9 per cent. and practically no phosphorus and very little sulphur. Fortunately, it can be made from relatively low-grade ores, but, at present, production is not on a scale to furnish large amounts to the steel industry. So far, the cost of the material has been somewhat higher than an equivalent amount of manganese in the ferro-alloy form. Whether, in the event of restricted imports and the resulting rise in prices for other varieties, and the lowered costs incident to larger-scale production, the situation might change cannot now be predicted. Experiments by the Jones and Laughlin Steel Corporation have indicated that the behaviour of the electrolytic product is essentially the same as that of ferro-manganese in open-hearth steel. A comparatively small tonnage of this low-carbon, high-manganese product would be used, and a further economic advantage would be the furnace time saved in not having to reduce the carbon in the heat to compensate for that added with ferro-manganese. Manganese metal containing 95 per cent. to 98 per cent. of the element is produced by the Thermit process; hitherto it has been unable to compete economically with ferro-manganese. The commercial product contains about 1 per cent. of either silicon or aluminium, or both.

Ferro-manganese is an alloy containing approximately 80 per cent. of manganese, about 16 per cent. of iron, and with the carbon up to about 6 per cent. or 7 per cent., depending on the method of production. It is the material usually made from high-grade manganese ores, or concentrates, which, for the most part, are imported, and it is probably the most convenient form in which to add manganese. To avoid the addition of carbon to low-carbon, high-manganese steels, an electric-furnace product containing much less carbon than the usual blast-furnace alloy is sometimes used. The consumption of this material, however, is small, and its cost is perhaps twice as great as that of the alloy made in the blast furnace. For certain killed steels, silico-manganese with the approximate composition 65 per cent. to 70 per cent. of manganese, 12 per cent. to 25 per cent. of silicon, and 1·2 per cent. to 2·5 per cent. of carbon, is preferred. Ferro-manganese has the distinct advantage over other forms of manganese alloys that considerable percentages of manganese (perhaps as much as 1·5 per cent.) can be introduced in the ladle without cooling the steel excessively. It is of interest to note that during the war of 1914-18 the manganese content of ferro-manganese was permitted to fall as low as 60 per cent.

Spiegeleisen is the other form of alloy commonly used for introducing manganese. It usually contains about 20 per cent. of the element (a 27-per cent. grade is also on the market), although in 1918 a product with as little as 16 per cent. was considered acceptable. The remainder of the alloy consists of iron plus about 5 per cent. of carbon and perhaps 0·5 per cent. of silicon. The fact that about 148,000 tons were produced and imported in 1936 indicates its current use. At present much the larger proportion of spiegeleisen is made from home-produced ores. The use of silico-spiegel, which contains perhaps from 25 per cent. to 30 per cent. of manganese and from 7 per cent. to 8 per cent. of silicon, is limited in the industry. Spiegeleisen is a satisfactory substitute for the ferro-alloy in making additions of manganese, provided that the accompanying elements, such as carbon and phosphorus, are consistent with the grade of steel being made. For example, spiegeleisen as a recarburiser for rail steel replaces pig iron as a source of carbon and ferro-manganese as a source of manganese. Difficulties resulting from cooling the steel by additions of too large an amount of cold spiegeleisen, either in the furnace or in the ladle, may be avoided by preheating or pre-melting the added material. Manganiferous pig iron containing perhaps 5 per cent. of manganese can be used for additions when the amount required is not too great or may be supplemented by the use of ferro-manganese. For additions in the ladle this substance may be used in the molten condition.

Methods of Economising Manganese.—A variety of schemes have been proposed for reducing the amount of manganese required for the production of satisfactory steel. These suggestions may be divided into the following classes:—(*a*) Economy in the amount of manganese employed; (*b*) economy in the use of high-grade manganese by the substitution of low-grade material; (*c*) the substitution of other deoxidising agents; (*d*) the substitution of other substances, such as nickel or chromium, for strengthening agents; and (*e*) furnace procedures designed to reduce the amount of material needed. Item (*a*) is intended primarily to cover the consumption of manganese in steel used for purposes for which material of lower quality would serve equally well; in other words, it refers to the manganese used to meet specifications, and a survey of the uses to which certain steels are put would probably result in some saving. The use of slightly higher carbon contents no doubt would offset the lower percentages of manganese in certain products without detriment to the structures in which the material is used. C. R. Ellicott suggested that when possible rimmed steel be substituted for the killed product, as less manganese is required in the manufacture of the former. As the use of rimmed steels has expanded considerably in recent years, the opportunities for saving manganese by this substitution are limited, but the point is worth remembering.

(To be continued.)

THE CURTISS-WRIGHT INTERCEPTOR-FIGHTER.

THE St. Louis Airplane Division of the Curtiss-Wright Corporation, Robertson, Mo., U.S.A., has recently demonstrated a new interceptor-fighter, known as the Curtiss-Wright Model 21-B, which climbs at the rate of a mile-a-minute vertically, and is said to be the fastest climbing military aeroplane produced so far. Possessing in addition to its high rate of climb, high speed, exceptional manœuvrability and heavy fire power, the new machine, which is illustrated in Figs. 1 and 2, on page 466, is a highly-streamlined, single-seater, low-wing all-metal monoplane with flush type retractable landing gear. It is powered with a 1,000-h.p. Wright Cyclone engine and its equipment includes an electric tell-tale, or warning signal, that automatically indicates any abnormal operating condition and is very useful to the fighter-pilot. This aircraft has been designed for intercepting enemy bombers after the "Alert" has been given and before they reach their objective. It takes off after only a short run, and this, combined with its steep angle and high rate of climb, enables it to operate from temporary aerodromes of small dimensions that can be located in the most convenient and effective positions for use against invading aircraft.

It is essential in designing interceptor type aircraft to keep the weight as low as possible in order to obtain the best performance, particularly with respect to rate of climb, and by careful selection of each piece of equipment used in constructing the Model 21-B it has been found possible to obtain an ultimate positive load factor of 11·1 at the normal gross weight of 4,500 lb., calculated by standard United States Army Air Corps methods. All major structural components of the machine, excepting the landing gear and engine mounting, are constructed of stressed aluminium-alloy sheet, generally 24ST Alclad. The latter is connected by A17ST aluminium-alloy rivets. Flat-head flush-type rivets are used where a smooth surface is aerodynamically important; in other areas the rivets have specially modified brazier heads.

The wing, which is of the internally-braced cantilever monoplane type, is composed of three separate panels. The centre panel is riveted to the fuselage and forms an integral structural unit with it. The main landing gear units, shown lowered in Fig. 2, are attached to, and retract inwards from, the outer ends of this centre panel, thus permitting the machine to be moved about on its wheels when the outer panels have been taken off. The wing structure is of the multi-cellular type, composed of five shear webs in the direction of the span and a number of formed ribs suitably spaced in the direction of the chord. Split trailing-edge wing flaps, of aluminium-alloy sheet construction, extend laterally from one aileron to the other, being attached to the wing with continuous type hinges. The flaps are hydraulically operated by means of a control valve located in the cockpit. The ailerons, which are of all-metal aluminum-alloy construction, each consist of a channel spar, channel ribs and sheet-metal covering. They are dynamically and statically balanced, and are provided with fixed tabs for the adjustment of the lateral trim. The aileron control is semi-irreversible.

The general arrangement of the empennage can be seen in Fig. 1. The tail plane is cantilevered from and integral with the fuselage, and is of all-metal construction, the skin and shear webs being of aluminum alloy and the ribs of aluminum-alloy sheet. The fin construction is similar to that of the tail plane, being cantilevered from and integral with the fuselage, and of aluminium-alloy construction. The fuselage is of semi-monocoque construction, the covering skin being of aluminium-alloy sheet. Longitudinally there are aluminium-alloy angle stringers with a Tee-shaped longeron on each side of the aircraft in the vicinity of the cockpit and forward, for the purpose of reinforcing the cockpit cut-out and taking the engine-mounting loads. The lateral fuselage frames or rings are of aluminum-alloy sheet formed into the shape of a channel in cross section. The fuselage is riveted to both the wing centre section and the fixed parts of the empennage to form a single integral unit. The engine mounting is of chrome-molybdenum steel-tube construction with a steel-tube mounting ring which is fixed to the fuselage by four fittings of the quickly-detachable type.

The main landing gear, seen in Fig. 2, consists of two 27-in. smooth contour tyres and 27-in. streamline wheels mounted on cantilever shock-absorber struts of the oleo-pneumatic type. The wheels are equipped with hydraulically-operated brakes, individually operated through separate toe pedals mounted on the rudder pedals. The gear is actuated hydraulically by a retracting cylinder and piston. It is locked in the "down" position by the geometrical arrangement of the mechanism and is locked "up" by means of an eyebolt on the axle which trips a spring-loaded hook. A special warning signal is provided on the instrument tell-tale panel. The tail wheel is retractable, and is

fully swivelling and steerable. It is retracted hydraulically simultaneously with the main landing gear.

The power unit consists of a Wright R 1820-G 5 Cyclone direct-drive engine with a two-speed supercharger and a non-icing pressure carburettor. The complete assembly of the power plant forward of the firewall may be readily removed and replaced. The propeller is of the three-blade automatic constant-speed type, and a constant engine speed within the useful range of angles is maintained by means of a governor mounted on the engine and controlled from the cockpit. The exhaust collector, which is of stainless steel, directs the exhaust gases out the bottom of the engine cowl; the employment of a non-icing type of carburettor renders a carburettor air heater unnecessary. The engine cowl is of aluminium-alloy sheet reinforced with channel and hat-section stiffeners, and is made in three parts, each covering approximately 120 deg. of the engine periphery. A notable feature is that the two upper parts are fitted tightly to the fuselage at the rear of the cowling, so that the cooling air enters the front of the engine compartment evenly around the periphery of the engine and escapes from the bottom only. No oil, heated air, or exhaust fumes are therefore directed over the top or sides of the fuselage in such a way as to enter the cockpit. A sealed fireproof and heat-proof bulkhead, having an asbestos core with aluminium-alloy sheets on the front and back, separates the power plant from the fuselage. Two integral fuel tanks, each of 50 gal. capacity, are located in the centre section, and the engine lubricating system comprises an oil tank, oil cooler and regulator, drain outlet, pressure indicator, temperature indicator, and pressure, suction and vent lines and fittings. The volume of the oil tank is sufficient for 9·5 gal., but only 8·5 gal. are carried, the remaining volume being allowed for expansion. The electrical system, which operates at 12 volts, comprises a battery, generator, ammeter, starter, gun controls, navigation lights, cockpit and instrument lights and suitable switches, rheostats, circuit breakers, conduit and wiring. In general, the controls are operated by extra-flexible steel cables running over ball-bearing pulleys or by rigid push rods and bell-cranks. The ailerons and elevators are operated by a conventional control column which is equipped with a standard gun-control switch in the handgrip.

The cockpit is fitted with an adjustable pilot seat and safety belt, complete engine controls including propeller-speed control and supercharger-speed control, flap and landing-gear control valves, hydraulic hand pump, differential and parking-brake controls, starter, battery and light switches, fuel-selector valve and pump controls, and a map case, instruments and other equipment. Complete cockpit lighting is provided for night flying. The cockpit is completely enclosed with a transparent plastic windshield and longitudinally sliding enclosure; the latter is adjustable. The fuselage structure immediately behind the cockpit is reinforced with a ¼ in. steel bullet-proof bulkhead and the skin is specially reinforced to protect the pilot's head and shoulders from gun fire from the rear or from serious injury if the plane should be completely overturned on the ground. Provision has been made for installing an additional section of bullet-proof armour plate below the bullet-proof bulkhead and covering the area behind the pilot's seat. An oxygen tank of 22 cub. ft. capacity may be installed behind the cockpit, and the radio equipment, when provided, consists of complete receiving or transmitting sets or both. Additional fuel tanks of 28 gallons total capacity may be installed. Landing flare provisions consist of racks, controls and aluminium-alloy containers to mount two Type A-8 parachute landing flares.

The armament normally provided consists of four machine guns, viz., two Colt-Browning MG40 0·30-calibre and two Colt-Browning MG53 0·50-calibre guns mounted in the fuselage and firing through the propeller disc. All are located near the line of sight for accuracy of fire and the ammunition boxes are arranged so that they may be readily loaded or removed through the top of the fuselage. The guns are controlled electrically by means of a trigger in the control-stick handgrip. Special dual synchroniser drives mounted on the engine are used. Additional armament, however, may be installed in the machine, the wing guns being mounted on the under surfaces of the wing outer panels, and each unit being entirely enclosed by a housing. The ammunition boxes in this case are located in the wings directly above each gun.

The tell-tale system, previously mentioned, consists of an electrically lighted warning signal panel which not only attracts the pilot's attention to any abnormal operating conditions of the aircraft, but also indicates the specific item; it contains eight sets of lights showing: fuel-pressure low, oil-pressure low, tank selector off, mixture lean, low propeller-revolutions setting, high blower setting, flaps down, and landing gear.

The new Curtiss-Wright interceptor-fighter has a wing span of 35·0 ft., is 26·3 ft. long, and 8·11 ft. high; it has a track of 8·93 ft. and a wing area of 174·3 sq. ft. The empty weight is 3,382 lb., the normal gross weight 4,500 lb. and the wing loading 25·8 lb. per square foot. The Wright Cyclone R 1820-G 5 engine with which it is fitted develops 1,000 h.p. at 2,200 r.p.m. for take-off, and is equipped with a two-speed supercharger which enables it to develop 1,000 h.p. at 5,600 ft. and 800 h.p. at 18,000 ft. The machine has a maximum speed of 314 miles per hour at 5,600 ft. and of 333 miles per hour at 18,000 ft. The cruising speed is 282 miles per hour at 12,200 ft., and the range at cruising speed is 630 miles. It will climb to 13,120 ft. in four minutes and to 16,400 ft. in five minutes. Fig. 1 shows the machine in a climb.

THE CURTISS-WRIGHT INTERCEPTOR-FIGHTER.

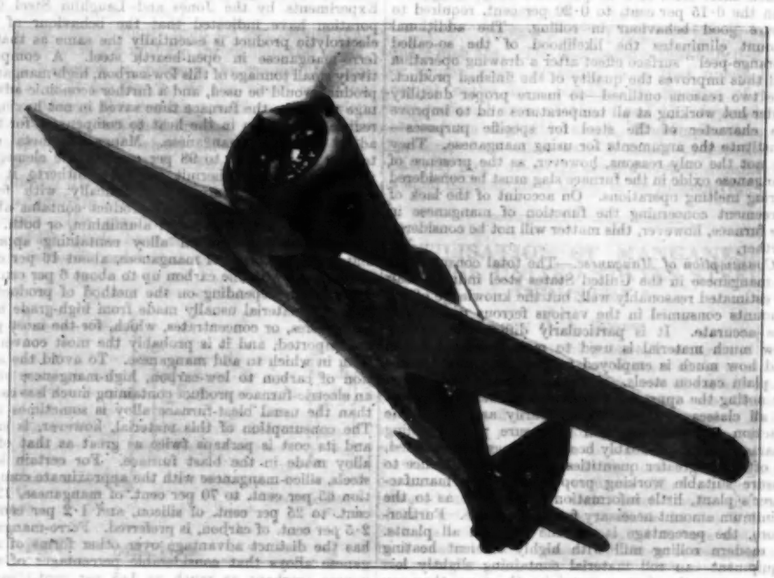


FIG. 1.

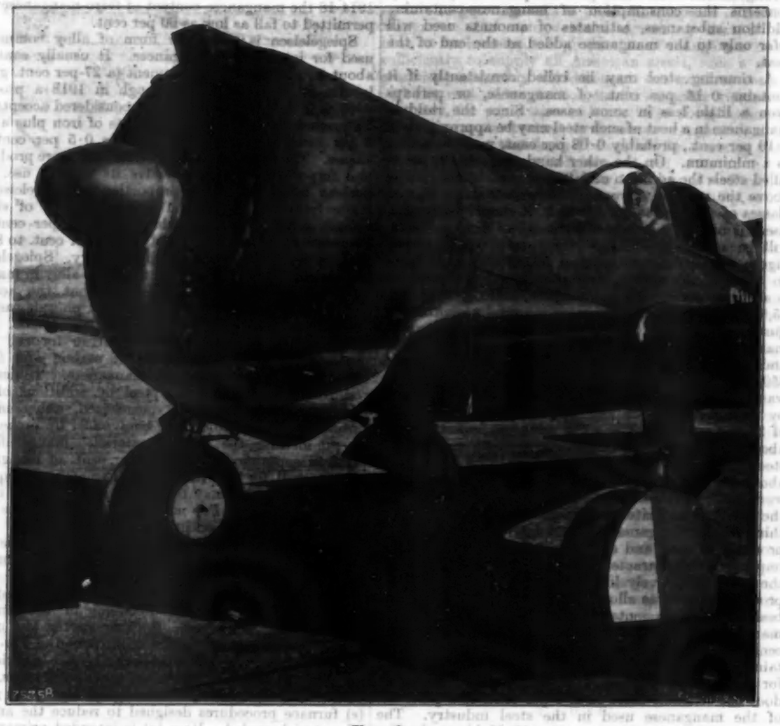


FIG. 2.

THE SUPPLY OF MACHINERY AND PLANT.—Under Statutory Rules and Orders, 1941, No. 777, which came into force on June 3, a general licence is issued authorising manufacturers to supply plant to any person carrying on a business in which machinery or plant specified in the schedules to the Machinery and Plant (Control), No. 2 Order, 1940 (S.R. & O., 1940, No. 1363) or the Machinery, Plant and Appliances (Control) Order, 1940 (S.R. & O., 1940, No. 2179) are employed, in temporary substitution for goods which are undergoing repair or reconditioning or are being replaced by other similar goods. The licence is issued subject to certain conditions specified in the Order. Inquiries should be addressed to the Industrial Supplies Department, Machinery Licences Division, Board of Trade, 1–6, Tavistock-square, W.C.1.

LIGHT PORTABLE FIRE PUMPS.

MESSRS. COVENTRY CLIMAX ENGINES, LIMITED, COVENTRY.

FIG. 1. UNLOADING WHEELBARROW-TYPE PUMP FROM TRAILER.

FIG. 2. "WHEELABOUT" FIRE PUMP.

LIGHT PORTABLE FIRE PUMPS.

On several previous occasions we have described various types of trailer fire pumps, which are self-contained engine and pump units permanently mounted on a trailer for towing behind a car or other vehicle. Messrs. Coventry Climax Engines, Limited, whose headquarters are at present at The Grange, Newbould-on-Stour, Stratford-on-Avon, make large units of this type, but we propose now to deal with a lighter man-handled unit. This appliance can be kept on a particular site and wheeled about to the required position on that site, or it can be loaded on to a carrying trailer and transported from site to site, being then unloaded and run into positions inaccessible to the trailer. This type of fire-engine is shown in Fig. 1, on this page, the fireman being seen in the act of withdrawing it from the trailer. The front end of the tubular frame is masked by the side of the trailer, but it is carried on two wheels with pneumatic tyres, 10 in. in diameter, beyond which point it is prolonged into a pair of carrying handles. The unit, when removed from the trailer, can thus be either run where required wheelbarrow fashion, or carried by the handles at each end in the manner of a stretcher. This portability is a very useful asset, as the unit can be taken up or down steps, lifted over obstructions, and so forth, and can thus be taken to sources of water which a trailer might not be able to reach.

The unit can, of course, be loaded on to any type of vehicle if it is to be transported from site to site, the hose, suction strainer, etc., being handled separately. If the trailer shown in Fig. 1 is employed, this equipment is carried on it, there being provision for six 50-ft. lengths of delivery hose, two 10-ft. lengths of suction hose, suction strainer, tools, etc. The trailer is suspended on underslung semi-elliptical springs and has two detachable wheels with pneumatic tyres, 18 in. in diameter. There is a connection for towing by a vehicle, and for this method of transport 8-in. mechanical brakes with automatic over-run devices are fitted. The brakes can be hand-operated for holding the trailer when stationary and three adjustable jacks are provided for support in this condition. For manual handling of the trailer two folding tow bars are fitted and two lengths of manilla drag rope. The pumping unit is also fitted on a chassis of the type shown in Fig. 2. This form is known as the "Wheelabout" and is not designed for towing behind a vehicle, but for handling by man power within comparatively small areas, as, for instance, on shipboard and in institutions, schools, etc. It can be run about rather more readily than the type shown in Fig. 1, as the wheels are larger, and lifting handles, adjustable jacks and eyelets for drag ropes are provided. It is not, of course, fitted with brakes. The weight complete is about 4 cwt. The hose equipment for this type must be transported independently.

Dealing with the pumping unit apart from questions of transport, this is known as the F.S.M. model. Its delivery, with a vertical suction of 10 ft., at a pressure of 60 lb. per square inch in the delivery is 225 gallons per minute, at 100 lb. per square inch 155 gallons per minute, and at 120 lb. per square inch 130 gallons per minute. If required for foam fire-extinguishing, the unit will produce 1,350 gallons of foam per minute when using three foam-making branch pipes. Sectional views of the engine and pump are given in Figs. 3 and 4, and of the exhaust pump priming device in Fig. 5, all on page 470. The engine, which is of the petrol four-stroke cycle type with side valves, has four cylinders, 56 mm. bore by 86 mm. stroke, and develops 23 brake horse-power at 3,500 r.p.m. The R.A.C. rating is 7·76 h.p. The pump, seen on the right in Fig. 3, is of the firm's single-stage F.S.M. centrifugal type, with a 3-in. nominal suction inlet. The casing is formed with a flange bolted to the flywheel casing, which, in turn, is spigoted into and bolted to the engine crankcase and carries the outer crankshaft bearing. The delivery branch is fitted with a screw-down valve and a 2½-in. instantaneous quick-release female half connector. The position of both the suction and delivery connections are seen to the left of Fig. 2. Transmission to the pump spindle is by means of a flexible coupling bolted to the flywheel and fitted on a splined portion of the spindle, the end of which is supported in a bushed recess in the crankshaft.

Although the pump body can be distinguished in both Figs. 1 and 2, the engine, being housed under the bonnet is not visible. The 4-gallon petrol tank at the front, identified by the filler cap on the top, provides a sufficient supply for 3½ hours continuous running at full throttle. Immediately next to the petrol tank, and under the bonnet, is a tank of rather larger capacity for the cylinder cooling water. The water circuit is a closed one on the thermo-syphon system, the cooling of the water being effected by a cooling coil in the tank through which water, drawn from the centrifugal pump discharge, is passed and discharged to waste. This water is strained before passing into the coil by the dual filter, seen on the front of the bonnet in Fig. 2, in order to avoid choking of the coil should muddy water be handled. The engine passages are not, of course, liable to be choked, since the water in the tank, which may be treated with anti-freezing mixture, is constantly circulated and any loss caused by evaporation is made good by the addition of clean water. The other fittings seen near the filter in Fig. 2 are connected with the pump priming device.

This is shown diagrammatically, and, therefore, not precisely to scale nor with the several parts in their actual relative positions, in Fig. 5. Its function is to produce a partial vacuum in the suction hose so that the pump will start rapidly, the vacuum being created by by-passing the engine exhaust through a nozzle, similar to that of a feed injector, inserted in a pipe leading from the pump suction branch. The connection with this branch is made through a cylindrical water trap readily distinguishable in Fig. 2 and identified at *a* in Fig. 5. The top of the trap communicates with a strainer box, containing a valve *b*, which, except at starting, is closed by an external spring. In Fig. 5, this valve is shown open, the spring having been compressed by a finger on a shaft rotated by the priming lever *c*, which, when priming is being effected, is held down in the horizontal position. In Fig. 2, the priming lever, terminating in a knob, and the finger are seen in the vertical position, which is the normal position when the pump is working. Referring again to Fig. 5, the lower part of the engine exhaust manifold is seen to the left, the gases normally escaping through the pipe at the bottom. The passage, when priming, is closed by the valve *d*, which is connected by a rod and levers to the priming lever. Depression of the priming lever opens valve *b* and closes valve *d*, the exhaust gases being diverted through the injector nozzle and the air in the suction hose being, in consequence, evacuated. The actuating system of valve *d* is not, of course, distinguishable in Fig. 2, but the exhaust manifold can be recognised to the right of Fig. 4, and this, in conjunction with Fig. 5, will enable the actual relative positions of the parts of the priming system to be visualised. The position of the water trap connection on the pump suction branch is clearly shown on the right in Fig. 3.

The operation of priming should take considerably less than the maximum of 45 seconds if the various joints are tight, since, when a cap is placed on the pump suction inlet, the exhausting effect produces a vacuum of 24 in. of mercury at least. This is shown

on the gauge seen to the right of the instrument panel in Fig. 2. This gauge is a compound one, reading vacuum and pressure, respectively, on each side of the zero mark. The latter graduations indicate the pressure on the suction when it is connected to a hydrant or is in series with another pump. The gauge on the left indicates the delivery pressure. The smaller circles seen above these gauges are, at the left, the choke knob, and, at the right, the lubricating-oil pressure gauge. The short lever below the delivery-pressure gauge is the engine throttle and the knob below the compound gauge is the ignition switch. The whole of the controls are thus conveniently grouped.

Referring now to the drawings of the engine shown in Figs. 3 and 4, it will be observed that the cylinder block and crankcase consist of a single casting, the sump being formed of a light sheet pressing. The whole of the facings of the casting are ground and the cylinders are honed. There are two main bearings, one of which is carried in the main casting and the other in the flywheel casing. The crankshaft can be withdrawn after removal of this casing. Correct alignment of the bearings is ensured by the spigot on the flywheel casing and the bearings are fine-bored with the casing bolted in place. The bearings are of phosphor-bronze lined with white metal, and are 2 1/16 in. and 2 1/4 in. in diameter for the front and pump ends, respectively. The two inner connecting rods work on a common crankpin with a balance weight between them. The crankpins are 1 1/4 in. in diameter. The shaft is drilled for main bearing and big-end pressure lubrication, as shown. The connecting rods are drop-forged with marine-type big-ends fitted with steel-backed white-metal bearings. The gudgeon pin ends have phosphor-bronze bushes pressed into position. Both the crankshafts and connecting rods are tested in balancing machines before assembly in the engine. The pistons are of tinplated aluminium alloy and have two compression rings and one scraper ring. The cylinder head is a single casting with adequate water-jacket, as shown in Fig. 4.

The valve arrangement will be clear from the figures. The valves are of a special alloy and the whole eight are ground in simultaneously and automatically in a machine designed for the operation. The camshaft, which is chain-driven from the crankshaft, has the cam profiles automatically ground from the black shaft. The shaft on the opposite side of the crankcase drives, through spiral gearing, a vertical shaft, at the bottom of which is the gear-type lubricating-oil pump and at the top the magneto. This shaft is also fitted with a cam, which reciprocates the plunger of the petrol pump, as shown at the left of Fig. 4. The pump draws from the petrol tank and delivers to a down-draught carburettor. A small lever in it enables the carburettor to be charged by hand when starting from cold, the engine being turned over by a crank handle of the usual type. The lubricating-oil filler cap is seen above the petrol pump, with a strainer round the magneto shaft, and the sump dipstick is seen below it. The lubricating pump draws directly from the sump and delivers to a manifold inside the crankcase, whence the oil is supplied to the various bearings. The delivery is, however, through an oil cleaner mounted externally near the exhaust priming ejector, a spring-loaded by-pass being fitted so that, should the filtering element become choked, the bearing supply is not interrupted. The sump capacity is 6 pints.

The constructional details of the pump scarcely call for comment since the sectional view, Fig. 3, illustrates all the characteristic features, but it may be noted that the main parts, including the volute body, shaft and impeller are made of corrosion-resisting metals, the impeller, for instance, being of phosphor-bronze. Some notes on the testing of the sets may be added. The engines are run for half-an-hour on light load and for two hours to three hours at full load, the speed being increased gradually. The power developed is measured by Heenan and Froude dynamometers. The pumps, before coupling to the engines, are tested hydraulically to 250 lb. per square inch. The complete units undergo other tests; for example, to ensure capacity for full throttle operation as soon as the engine is started, to verify the amount of water pumped at various engine speeds, and to estimate endurance. The water delivered is measured by orifice-type gauges and suction heads of 10 ft. and 24 ft. are employed. For endurance, one set in every 20 is run for a long period, after which it is dismantled for examination.

SCHOLARSHIP IN OPTICS.—A scholarship in optics, tenable for a minimum of two years at the Imperial College of Science and Technology, South Kensington, and having a value up to 40*l.* per annum, has been established by the Scientific Instrument Manufacturers' Association of Great Britain, Limited, 66, Queen Victoria-street, London, E.C.4.

BRITISH STANDARD SPECIFICATIONS.

THE following specifications of engineering interest have been issued by the British Standards Institution. Copies are obtainable from the Publications Department of the Institution, 28, Victoria-street, London, S.W.1, and, unless otherwise stated, the price is 2*s.* net, or 2*s.* 3*d.* including postage.

Lac.—The new specification for lac, No. 954-1941, is concerned solely with "whole" natural lac. This implies all lac material, whatever its physical form (apart from debris of the lac insect and other adventitious matter) preserved throughout the processing operations to which the material may have been subjected. The specification deals with sampling procedure and freedom from foreign matter, ash content, iodine value, matter insoluble in sodium-carbonate solution and in hot alcohol, solubility in cold alcohol, acid value, volatile matter, arsenic and lead contents and other characteristics of the material. The method of test for each is given in appendices. The special requirements of different users of lac have been met by detailing first those clauses which apply generally, irrespective of use. These are followed by clauses for material employed in specific applications.

Linen Fabric for Aircraft.—In view of the present national emergency the Ministry of Aircraft Production is permitting the use of Irish flax in the manufacture of linen fabric and tape. The necessary modifications to specification C.F.1, for 4 oz. linen fabric and tape, relating to the requirements for the counts of yarn and the weave, weight and strength, are given in a revision slip designated C.F. (A.C.) 7443. This may be obtained gratis by sending a stamped addressed envelope to the British Standards Institution.

Aluminium-Alloy Tubes.—A revision of the specification for aluminium-alloy (Duralumin) tubes has recently been published. This is numbered 5T.4, and cancels the previous specification No. 4T.4. The essential feature of the revision is the amplification of the clauses on mechanical testing, and of the table of tube sizes, to include details of the physical properties. The proof bending test is specified for circular tubes over 1/2 in. in diameter. Notes on the table, indicating the basis for calculating the tolerances and other dimensions, have been included. [Price 1*s.* net, or 1*s.* 3*d.* including postage.]

BOOKS RECEIVED.

University of Minnesota. Institute of Technology. Engineering Experiment Station. Technical Paper No. 20. *Supercharging a Stock Engine.* By PROFESSOR B. J. ROBERTSON. Technical Paper No. 23. *The Effects of Insulation, Weatherstripping, and Fan Operation on Air Filtration.* By F. B. ROWLEY and R. C. JORDAN. Technical Paper No. 24. *The "Plug" Method for Obtaining the Compressive Elastic Properties of Thin-Walled Sections.* By H. W. BARLOW, H. S. STILLWELL and HO-SHEN LU. Minneapolis, Minn., U.S.A.: The Director, The Engineering Experiment Station, Institute of Technology, University of Minnesota.

United States Bureau of Labor Statistics. Serial No. R. 1238. *Hourly Earnings in the Enameled-Utensil Industry, August, 1940.* By S. C. SUFRIN, P. L. JONES and J. F. LACISKEY. Washington: Superintendent of Documents.

United States Bureau of Mines. Technical Paper No. 622. *Hydrogenation and Liquefaction of Coal.* Part I. *Review of Literature, Description of Experimental Plant, and Liquid-Phase Assays of Some Typical Bituminous, Sub-bituminous and Lignite Coals.* By H. H. STORCH and others. [Price 20 cents.] Technical Paper No. 623. *Coke-Oven Accidents in the United States During the Calendar Year 1939.* By W. W. ADAMS and V. E. WRENN. [Price 5 cents.] Technical Paper No. 624. *Increasing the Concentration of Sulfur Dioxide in the Effluent Gases from Dwight-Lloyd Sintering Machines Treating Lead Products.* By VIRGIL MILLER, R. BAINBRIDGE and R. ELLISON. [Price 10 cents.] Washington: Superintendent of Documents.

United States National Bureau of Standards. Miscellaneous Publication No. M168. *Protection of Documents with Cellulose Acetate Sheeting.* By B. W. SCRIBNER. Washington: Superintendent of Documents. [Price 5 cents.]

United States Bureau of Mines. Technical Paper No. 625. *Thermodynamic Properties of Gypsum and Its Dehydration Products.* By K. K. KELLEY, J. C. SOUTHARD and C. T. ANDERSON. Washington: Superintendent of Documents. [Price 10 cents.]

Transactions of the Institution of Water Engineers. Volume XLV. 1940. Edited by A. T. HOPPE, Secretary, Offices of the Institution, Winsford, Heathside-road, Woking.

The Identification of Molecular Spectra. By DRS. R. W. B. PEARSE and A. G. GAYDON. London: Chapman and Hall, Limited. [Price 42*s.* net.]

PERSONAL.

MR. WILFRED E. REDFERN, founder of Messrs. Redfern's Rubber Works, Limited, Hyde, Cheshire, has retired from the chairmanship of the Company but retains his seat on the board. His brother, MR. J. ARTHUR REDFERN, has been elected chairman, and his son, MR. THOMAS H. REDFERN, deputy chairman.

MR. J. LEGG has been appointed assistant engineer-in-chief of the Post Office Engineering Department.

MESSRS. RYLANDS, BROTHERS, LIMITED, have removed their London office from Leadenhall-street, E.C.3, to 22, Leonard-court, Kensington High-street, W.8.

MR. J. W. GARTON, secretary of Messrs. Brown Bayley's Steel Works, Limited, Leeds-road, Sheffield, 9, has been elected a director of Messrs. Hoffmann Manufacturing Company, Limited, Chelmsford, Essex.

MESSRS. TANGYES, LIMITED, Cornwall Works, Birmingham, inform us that their new London address is: Grantie House, 7th Floor, Cannon-street, E.C.4. (Telephone, Mansion House 4577; Extension 11.)

The London office of MESSRS. GEORGE SALTER AND COMPANY, LIMITED, has been transferred from No. 50 to No. 37 Lime-street, E.C.3.

MR. J. M. R. FAIRBAIRN, past-President of the Engineering Institute of Canada, and formerly Chief Engineer of the Canadian Pacific Railway Company, has been appointed director of works and buildings, Naval Service, Department of National Defence, Ottawa.

MESSRS. E. DUFFIELD and J. A. SYERS have been appointed vice-chairmen, managing directors and joint general managers of Messrs. Yorkshire Copper Works, Limited, Pontefract Road, Stourton, Leeds.

MR. W. B. WEST, B.Sc., who was editorial representative of ENGINEERING in the United States for a number of years and who has been engaged more recently on engineering work in Africa, has relinquished his connection with this journal.

TRANSPORT OF GRAIN IN BUENOS AIRES.—A statement issued by the Argentine Minister of Public Works shows that 1,297,982 tons of cereals were conveyed from the centres of production to the various maritime ports in the Province of Buenos Aires for shipment. Out of this total, 26 per cent. were conveyed to the ports in motor road vehicles and the remainder by rail.

CONDENSING PLANT AND COOLING WATER SYSTEMS: ERRATA.—We regret that, owing to the fact that our abridgment of Mr. W. T. Bottomley's paper on the above subject was made from an advance copy, a few errors occurred on page 439, *ante*. In the left-hand column, in line 7, R*v* should read R'*v* and the same error was made in line 12, and also in the reference to the ordinate scale on the left of Fig. 8. In line 14, for R read R' and in equation (16) near the top of the centre column, $\frac{\theta_m}{x}$ should read θ_m. It is hoped that, as these errors are fairly obvious, they will have been detected without difficulty.

THE LATE MR. M. R. F. H. STUART.—Mr. Martin Richard Furneaux Hennessy Stuart, whose death, we regret to record, took place, after a seizure, in St. George's Hospital, London, on May 14, was commercial manager to Messrs. Davey, Paxman and Company (Colchester), Limited. He was in his fifty-first year and had received his education at a preparatory school in Broadstairs, Kent, and later at Heidelberg, Germany. He became an articled pupil in the works of Messrs. Davey, Paxman and Company in 1908 and continued in their employ on the conclusion of his apprenticeship. On the outbreak of the war of 1914-18, he joined the Royal Army Ordnance Corps and after the conclusion of hostilities served as a member of the Inter-Allied Commission of Control in Germany until 1922. Mr. Stuart left the Army with the rank of Major and resumed his connection with Messrs. Davey, Paxman as assistant works manager. He was later transferred to the Company's London office as assistant to the London director. Subsequently, Mr. Stuart was attached to the export staff of Messrs. Agricultural and General Engineers, Limited, for whom he travelled extensively. On the liquidation of that company he joined Messrs. Davey, Paxman and Company (Colchester), Limited, on its formation, as London manager. Later, in the capacity of commercial manager, he took charge of the whole of the sales and contracts activities of the Company and he was carrying on this work at the time of his death. He became an associate member of the Institution of Civil Engineers in 1919 and an associate member of the Institution of Mechanical Engineers in 1931.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Welsh Coal Trade.—The difficulty that has arisen in connection with the payment of the bonus under the Essential Work Order, which was applied to the coal industry as from May 31, continued to attract a good deal of attention during the past week on the steam-coal market. The South Wales Miners' Federation had the matter under consideration and it was stated that though the bonus was not operative, the men considered that when agreement was reached it should be made retrospective to June 3, when the work was resumed after the Whitsun break. The price of Welsh coals, in common with those in all other parts of the country, were advanced in price by 10*d.* per ton in order to cover the expense of the bonus payments. Very heavy demands continued to be made on the steam-coal market. Inland buyers were still anxious to obtain supplies for stocking purposes as a precaution against any emergency that might arise next winter. In addition there was no reduction in the demand from industrial users, and despite the steady improvement that continued to be made in outputs, producers were finding it difficult to meet requirements. The best feature of the market continued to be presented by the bituminous small descriptions. These were scarce and a strong demand was difficult to stem for some time to come and the best large sorts were being steadily absorbed by deliveries on account of existing contracts. Dry steam smalls were in ample supply to meet a slow request and the tone was consequently dull. Cokes were in brisk request and busy, but patent fuel remained quiet.

The Iron and Steel Trade.—Busy conditions continued in the iron and steel and allied trades of South Wales and Monmouthshire during the past week. The demand for the various finished products was actively maintained, but most producers held well filled order books and the amount of new business that could be included was therefore limited.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—Inquiries at the steel and engineering works show that outputs have risen steadily during the past three months. Steel supplies are good and the demands of consumers working on Government contracts are being met satisfactorily. Commercial orders on export account are also receiving satisfactory treatment. There is considerable activity in the raw and semi-finished steel sections. The demand is such that several firms are considering the installation of new plant in addition to that installed during the past year. The call for basic steel is considerably larger than it was six months ago, and the consumption of acid steel is also increasing. Supplies of pig iron, hematite, scrap and steel-making alloys are ample to cover requirements. Activity still continues in the heavy machinery and engineering branches. Inquiries are more numerous, but export business is naturally restricted. Machinery of all types is in demand on home account. Grinding and crushing plant for iron ore and similar raw materials is in strong demand, and there is a heavy call for concrete and cement-making machinery and excavators. Steelworks' and ironworks' machinery and reconditioned machines find a ready sale. Reports from the medium branches indicate that the flow of orders shows no sign of diminution. Light types of grinding machines are in demand by the agricultural and grain producing industries. Sheffield is supplying much material to makers of tractors and threshing machines, and firms turning out agricultural machinery parts and implements are on overtime.

South Yorkshire Coal Trade.—Outputs at the pits in this area show a tendency to increase, and absenteeism among colliery workers is diminishing. The current demand for industrial coal reaches a high level. Steams are in steady request and large quantities of smalls and slacks are being absorbed by gas and electricity works. The house-coal market is satisfactory, and the demand for all types of cokes shows little change.

INSTITUTION OF ENGINEERS, AUSTRALIA.—The report of the Council of the Institution of Engineers, Australia, presented at the recent annual general meeting of the Institution, shows that there were 4,385 members on the roll on December 31, 1940, as compared with 4,259 at the close of the previous year.

DE-INKING OF WASTE PAPER.—It is stated in a recent issue of *The Chemical Age* that the removal of printing ink from waste paper, prior to re-manufacture, can be facilitated by the addition of a small amount of a divalent nickel salt to the alkaline solutions used for this purpose. The agents used—nickel sulphate, for example—are effective in low concentrations, of the order of from 7½ lb. to 20 lb. per ton of dry paper stock.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

General Situation.—Producers of iron and steel continue to concentrate on meeting the requirements of the Government departments and war industries and with the help of extensive imports of most commodities, are dealing satisfactorily with the heavy demands. Parcels obtainable for ordinary industrial purposes are still few and small, but unloadings of material from the United States and the Dominions are likely to increase and to enable a larger tonnage to be released for general commercial undertakings. A possible change in the official quotations, owing to the rise in fuel prices, attracts little attention, interest being centred on the maintenance of deliveries.

Cleveland Iron Trade.—Supplies are ample to meet the steadily expanding demand for foundry iron though no improvement can be reported in the limited tonnage of Cleveland pig available for use. The output of local foundry iron is still intermittent and there is no indication of a resumption of the regular make. Midland ironmasters, however, are turning out sufficient tonnage to meet all requirements and are regularly delivering satisfactory parcels to the foundries of the North East Coast.

Basic Iron.—Basic-iron makers are maintaining production at a level that fully meets the heavy requirements of the local steelworks and provides a little tonnage for emergency stocks, but leaves no surplus for other purposes.

Hematite.—The situation in the hematite branch of trade is little changed. There is no likelihood of a material increase in the limited make, but the need for an enlargement of output is decreasing as imports of American products manufactured from hematite iron, expand. Delivery licences, however, are still granted only to consumers who are unable to use other iron and the strict rationing of customers is still essential.

Foreign Ore.—Mediterranean hematite ores are difficult to obtain but imports of other ores from abroad are quite adequate for current needs now that so much local and other native ironstone is passing into use in place of raw material from overseas. The Cleveland ironstone mines are supplying a much greater tonnage than has been the case for many years.

Blast-Furnace Coke.—Business in Durham blast-furnace coke matures very slowly though holders have substantial saleable parcels and the consumption is heavy. Local users are well bought and sellers are disinclined to add to their extensive bookings.

Manufactured Iron and Steel.—The supply of semi-finished iron and steel is ample. Consumers of billets, blooms and slabs are holding substantial stocks and are still taking considerable deliveries. The re-rollers have a great deal of work on hand. In the finished industries interest centres largely on the provision of material for the shipbuilding programme and special attention is being given to specifications for commodities needed for that purpose. Sheet makers are running their plant at full capacity to meet the heavy demand. The output of special alloy steels is taken up as it becomes available and railway requisites are in good demand.

Scrap.—Activity in the scrap market continues. Merchants are making exceptionally heavy deliveries and the supplies coming to hand from overseas are expected to cover adequately the abnormal requirements of users. Consumers of heavy steel scrap are glad of the opportunity now presented of laying in small stocks.

EXPORT OF METAL BARRELS AND TIN-PLATE GOODS.—Under a Board of Trade Order which comes into force on June 19, licences will be required for the export, to all destinations, of metal barrels and drums and certain articles manufactured entirely or mainly from tin-plate and terne-plate. The Order (S.R. & O., 1941, No. 742) also extends the control in respect of raw and fibre asbestos. Copies of the Order, price 1*d.*, are now available from H.M. Stationery Office, York House, Kingsway, London, W.C.2.

VILLAGE SALVAGE DUMPS.—From June 30, the village scrap iron dumps will be taken over by the Rural District Councils under the supervision of the Salvage Department, Ministry of Supply. The scheme organised by the Iron and Steel Control will be discontinued. This change, it is hoped, will result in the more rapid disposal of the material accumulated. In addition, all dumps operated by voluntary organisations are to be surveyed, and Councils will decide how many of the existing dumps should continue and whether more suitable sites could be found in some cases. Rural authorities have also been asked to include paper, rags, etc., in the dumps, provided suitable storage can be arranged. Voluntary organisers of dumps, in each parish, are being asked to continue with the new arrangements.

NOTICES OF MEETINGS.

IT is requested that particulars for insertion in this column shall reach the Editor not later than Tuesday morning in the week preceding the date of the meeting.

INSTITUTE OF PHYSICS.—*London and Home Counties' Branch:* Tuesday, June 17, 6 p.m., The Lecture Hall of Messrs. Kodak, Limited, Harrow. Lecture: "The Applications of Photography in Engineering," by Dr. D. A. Spencer.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Friday, June 20, 1 p.m., The Savoy Hotel, Strand, W.C.2. Summer Luncheon.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—Activity continues in the Scottish steel trade and all the works are fully employed. Shipbuilders are consuming a large tonnage of plates and sections and boiler-makers are also very busy and are specifying freely for the necessary steel materials. Sectional steel is in steady demand as structural engineers have many important contracts to execute. In the black steel sheet trade very active conditions prevail and both plain and galvanised sheets are in demand for essential purposes against priority orders. Supplies of raw materials are adequate, but the tonnage of steel scrap on hand is not as large as makers would like. The following are the present quotations:—Boiler plates, 17*l.* 12*s.* 6*d.* per ton; ship plates, 16*l.* 3*s.* per ton; sections, 15*l.* 8*s.* per ton; medium plates, ½ in. and thicker, rolled in sheet mills, 21*l.* 15*s.* per ton; black-steel sheets, No. 24 gauge, 22*l.* 15*s.* per ton; and galvanised corrugated sheets, No. 24 gauge, 26*l.* 2*s.* 6*d.* per ton, all for the home market.

Malleable-Iron Trade.—There has been no change in the state of the malleable-iron trade of the West of Scotland during the week and the works are well employed. The position of the re-rollers of steel bars has not changed and as the more pressing contracts are being rapidly cleared off any new business coming forward can be dealt with rapidly. Good stocks of semies are held at present. The current quotations are as follows:—Crown bars, 15*l.* 12*s.* 6*d.* per ton; No. 3 bars, 13*l.* 12*s.* 6*d.* per ton; No. 4 bars, 13*l.* 17*s.* 6*d.* per ton; and re-rolled steel bars, 17*l.* 15*s.* per ton, all for home delivery.

Scottish Pig-Iron Trade.—The demand for Scottish pig-iron is still heavy and production is being maintained at the maximum. The requirements of the steelmakers are very large and deliveries are being speeded up. Foundry grades of iron are moving rather slowly but a fair amount of business is passing. The supplies of raw materials are satisfactory. The following are to-day's market quotations:—Hematite, 6*l.* 18*s.* 6*d.* per ton, and basic iron, 6*l.* 0*s.* 6*d.* per ton, both delivered at the steel works; foundry iron, No. 1, 6*l.* 5*s.* 6*d.* per ton, and No. 3, 6*l.* 3*s.* per ton, both on trucks at makers' yards.

THE INSTITUTE OF TRANSPORT.—Owing to delays caused by the war, the annual report of the South African Centre of the Institute of Transport for 1939-40 has only recently been received in London. It shows a small decrease in membership which, however, stood at the satisfactory figure of 467 at the end of the year. The sub-centre at Johannesburg was able to carry out a full programme of meetings, but the Cape Town and Durban Centres found it impracticable to maintain normal activities. The report contains the interesting announcement that the Minister of Railways and Harbours has offered prizes for the two best papers on the development of a Ministry of Transport for South Africa.

AIR-RAID SHELTER VENTILATION EQUIPMENT.—The driving of the fans, which ensure normal ventilation and supply of pure air during a gas attack, in sealed air-raid shelters is in many instances effected by electric motors. There is, however, a risk of the current supply being interrupted and to counter this Messrs. Crompton Parkinson, Limited, Electra House, Victoria-embankment, London, W.C.2, have introduced a range of units which incorporate their "Minor" motor and have also an alternative hand drive by means of which the fans can be rotated at approximately the same speed as by the motors. The hand drive, either by single or double crank handles, is provided with a quick throw-off mechanism to eliminate risk to the operator in case of sudden restoration of the electric current. The larger units, viz., those for shelters to accommodate 100 persons, have also a centrifugal clutch which automatically disconnects the hand gear when the fans are being driven from the mains. Special attention has been paid to secure silent running of the units. The range of Crompton "Minor" motors enables single-phase, three-phase, or direct current to be utilised.

PETROL ENGINE AND PUMP UNIT FOR PORTABLE FIRE APPLIANCE.

MESSRS. COVENTRY CLIMAX ENGINES, LIMITED, COVENTRY.

(*For Description see page* 467).

Fig. 3.

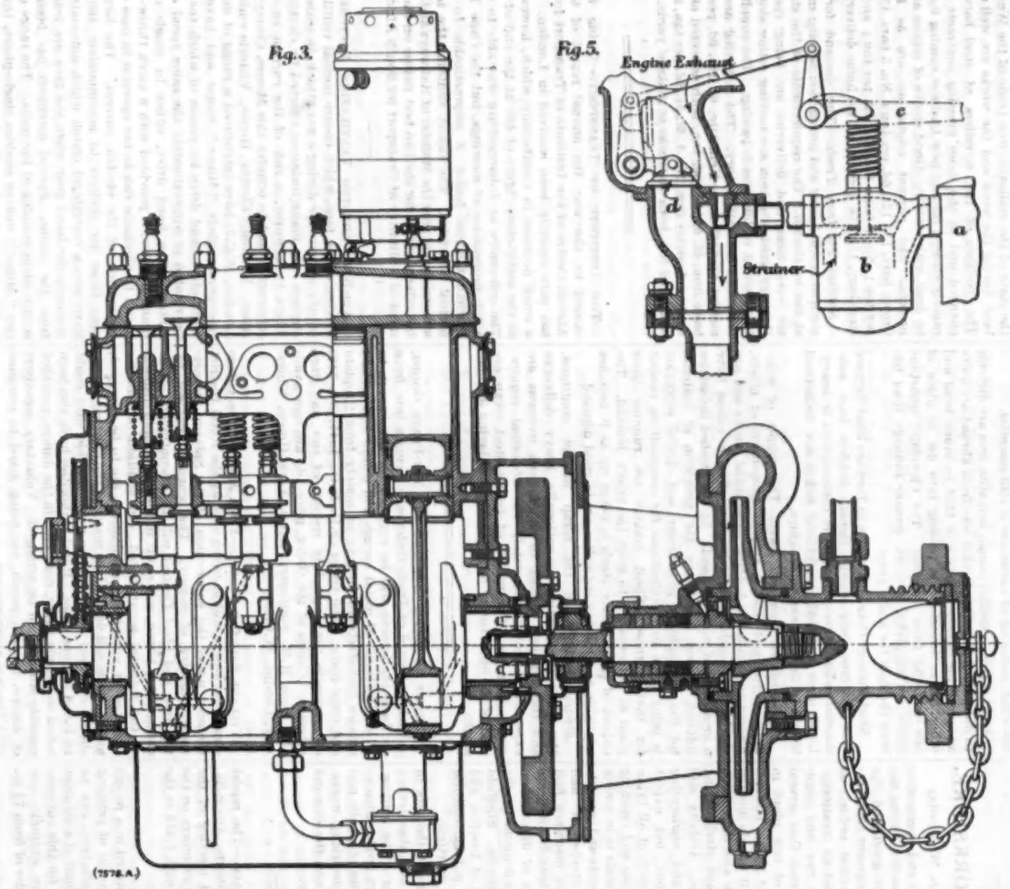
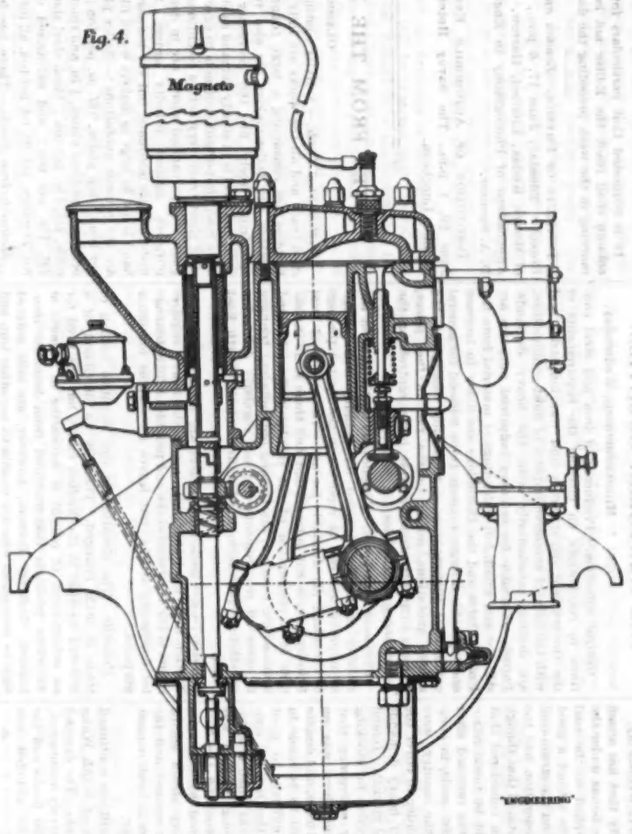


Fig. 5.

Fig. 4.



ELECTRO-TINNING OF PARTS TO BE SOLDERED.

In an account, on page 388 *ante*, of the research and technical development activities of the Tin Research Institute, as set out in its annual report for 1940, we mentioned that a long-standing objection to the electro-tinning of parts which have subsequently to be soldered had been traced to the adoption of too thin a tin coating. This appears to be converted, by diffusion, into an alloy layer not easily "wetted" by the molten solder. Some further particulars of recent work carried out in the Institute's laboratories, which has indicated that the thickness of the tin deposit is the decisive factor, are given in an article, by Dr. C. E. Homer and Mr. H. C. Watkins, printed in the current quarterly *Review* issued by the Institute. In a series of laboratory experiments, tests were made on pieces of steel sheet on which various thicknesses of tin had been deposited. Trial lap joints were made, using a soldering iron in the usual way; another method was to examine the spread of a small piece of solder on the fluxed surface. The results of both tests are stated to have been in complete agreement, but the spreading test was of particular interest in that it gave clearly visible and conclusive results. In the spreading test the specimens of steel sheet measured about 1 in. by 1½ in., and, after plating, they were painted over with a 20 per cent. solution of resin in methylated spirit. Small pieces, of equal length, of 50 : 50 tin-lead solder wire, after being dipped in the same flux, were placed in the centre of the specimens and these were gently heated, from above, with a flame until each piece of solder had melted and spread as far as it was able.

The test showed definitely which surfaces were satisfactory and which were unreliable for soldering purposes and it was established that, below a certain thickness, tin coatings were not satisfactory even if the solder were applied immediately after plating. The main result of the investigation was that minimum thicknesses of electro-tinned coatings, for soldering within six weeks of plating, can now be recommended. The minimum thickness on brass is 0·0002 in. (0·005 mm.); on copper it is 0·00015 in. (0·004 mm.); and on iron or steel 0·0001 in. (0·0025 mm.). It is emphasised that these recommended minimum thicknesses refer to coatings which are applied only for the purpose of facilitating soldering. If it is desired to sweat surfaces together without applying solder, a minimum thickness of deposit of 0·0005 in. is required, but in this case also, resin is a sufficiently active flux. Furthermore, where good protection against corrosion is needed, the tin coating should be greater than the minima stated. For the plating operation, the sodium stannate bath or the acid stannous sulphate bath are advocated, the former being particularly recommended for basket plating and the latter for barrel plating. The investigation has shown that using these baths and depositing coatings to the recommended thickness, the full advantages of pre-tinning before soldering are obtained, combined with a simple, reliable technique and the absence of traces of corrosive flux on the assembled parts.

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Classified advertisements intended for insertion in the current week's issue must be delivered not later than first post on Wednesday. Alterations to standing advertisements must be received at least 10 days previous to the day of publication. Passed proofs must be in our hands by Saturday morning, otherwise they will be taken as correct. The Proprietors will not hold themselves responsible for blocks left in their possession for more than two years.

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TEMPORARY ADDRESS.

For the duration of hostilities, the Editorial and Publishing business of this Journal is being conducted from 18 and 20, Compton Road, Hayes, Middlesex. The Telephone Number of the Editorial Department is Hayes 1730, and that of the Publishing Department, Hayes 1723. The Bedford Street Offices are open on Fridays only, between 10 a.m. and 5 p.m., for the distribution of the current issue and for retail sales.

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ENGINEERING

FRIDAY, JUNE 13, 1941.

VOL. 151. No. 3935.

ECONOMICS AND ÆSTHETICS.

IN the report of the luncheon of the Institution of Civil Engineers, on page 373, *ante*, we summarised briefly the reference by the President, Sir Leopold Savile, to the scheme which the Council had had under discussion, to finance the establishment of a lectureship in the economics and æsthetics of engineering design, with a view to the eventual inclusion of these subjects in the Mechanical Science Tripos of the University of Cambridge. Some further particulars are now available of the steps that have been taken to this end, and of the wider ideals that have inspired this first proposal. The offer by the Council, according to an announcement recently made, was the result of consideration of the need to foster among engineers the closer study of the economics of engineering projects, the organisation and management of engineering work, and the relations of æsthetic considerations to engineering design and construction. It was to cover an initial period of five years, in the hope that these subjects would form, in due course, part of the regular engineering curriculum.

The proposal has now been accepted in principle by the Council of the Senate of the University, but its adoption in full is recognised to be impracticable under war conditions, as it would necessitate a reconsideration of the present scheme of instruction. As a beginning, however, it is proposed that a number of eminent engineers and other suitable persons shall be invited to give either single lectures or short courses on subjects falling within the field contemplated. These introductory lectures are to commence in the next academical year, beginning in the autumn. The fact that this arrangement will benefit primarily the students at one university, however, is not to be taken as an indication that the Council of the Institution have set any such limit to their eventual aims. The present step is no more than a start in the direction that they believe to be necessary, and they intend to examine all possible means whereby the influence of the Institution can be usefully exerted to ensure that, in due time, such studies may form an integral part in the education of all engineers. It is recognised that the subjects mentioned enter into many departments of engineering work and that, in the light of changing economic conditions and the steady advance of scientific research, they require to be kept continuously under review. The period of reconstruction and development which will follow the present war is certain to give them increasing importance, and the Council believe that, in the national interest, engineers should be properly equipped in this respect in order to take their due share in the tasks that lie ahead.

The foregoing paragraphs summarise the general principles of the new development, so far as they have been officially stated, and there is no doubt that the publication of the first list of lectures, and the names of the lecturers, will be awaited with interest by many more than will be in a position to attend. It would be very desirable that some, if not all, of the lectures should be printed in order to reach a wider audience with the least possible delay; a desire which, we believe, will be endorsed by the many who have expressed, and the many more who feel, concern lest the needs of the moment may override, in the urgency of post-war reconstruction, those very considerations that the new scheme is designed to emphasise and influence. Not even the most pessimistic of war prophets envisages so prolonged a struggle that the present undergraduates in residence at Cambridge are likely to arrive in executive positions before that reconstruction can be taken in hand. It will be their task to complete it, perhaps, but the initial stages must be controlled by those whose college days are already well behind them; and it is they whose opinions will exert the first and possibly the most enduring influence in shaping the many works of restoration and reconstruction that must be set in train immediately the war is over.

There has been evidence enough in the buildings and in many of the engineering structures that have been erected in this country since the beginning of the present century that neither economic nor æsthetic considerations had been sufficiently appreciated by the engineers and architects responsible for their location, arrangement, or external appearance. It would be invidious to be more specific, and unfair not to recognise that questions of location and layout have been dictated, in many cases, by unavoidable circumstances; but there have been very many more cases in which convenience has been quite needlessly sacrificed to some purely architectural effect or, alternatively, has been studied to the complete exclusion of the other considerations that ought to carry weight in the design of any large structure, the mere existence of which becomes a factor in the daily lives of thousands who may have no direct concern with the purpose behind its construction. The extensive demolitions that the war is causing, and the opportunities for rearrangement thus afforded, will provide ample scope for a more thorough examination of the relative importance of such points; but, as we have said, the main principles of their application will have to be discussed and settled before the influence of any present or prospective undergraduates can become effective, and it is for this reason that the widest publication is desirable of the general guidance that the initial lectures are designed to provide.

At first sight, the terms in which the announcement by the Institution of Civil Engineers refers to the need for closer study of the three subjects named appear to do less than justice to the efforts that have been made in recent years to inculcate some knowledge of economics and management; for the associate-membership examination of the Institution of Mechanical Engineers has included compulsory papers on both subjects since 1924. It is true that instruction in them was almost unobtainable when this requirement was instituted, and for some time afterwards its quality and scope fell short of the desired standard. Latterly there has been a general improvement in this respect, and there is now no lack of competent exponents of the principles of works organisation and management as applied to manufacturing processes. As we read it, however, the intention behind the courses contemplated by the Institution of Civil Engineers is of a broader kind, and is designed to embrace works coming into the general category of public utilities. If this interpretation is correct, it is undoubtedly the case that the attainment of any degree of knowledge in either subject has been left largely to the individual to acquire by experience, supplemented only by such study as his predilections may have induced.

Even so, there should be no serious difficulty in finding sufficient lecturers to deal satisfactorily with either subject in general outline, or in supplementing their introductory addresses with others, devoted to particular aspects of these subjects. In due course, no doubt, we may expect to see a succession of text-books in which the principles will be properly expounded, with a suitable selection of illustrative examples drawn from actual practice; though the continuously varying circumstances will always leave considerable scope for the exercise of individual judgment and will prevent any tendency towards excessive standardisation of either instruction or practice. The most that can be aimed at is the development of a general appreciation of the principles, so that, in course of time, a thorough engineering training can be depended upon to ensure that the recipient will be no more likely to overlook their significance, in relation to his own work, than he would be to neglect any of the fundamental physical or mechanical principles upon which actual construction is based.

The problems of instruction in æsthetics are likely to be less easily solved, if only because æsthetic considerations must always depend so largely on questions in which personal opinion is paramount. Opinion is liable to be swayed by fashion to a greater extent than the holders of it may be willing to admit, and fashion itself is frequently the result of quantity rather than quality of production. Ready supplies of particular materials lead to their general adoption and so evolve a "fashion" which, in fact, owes little or nothing to æsthetic considerations. Gradually the fashion is assumed to be in some way characteristic of a period or a district and is copied elsewhere with that label attached to it. Opinions developed in this way, however, are necessarily of slow growth; but modern engineering progress is much more rapid and may easily cause changes to take place at a greater rate than the natural growth of opinion can accommodate. Thus, for example, the use of structural steel and concrete in conjunction, as in a bridge, seems incongruous if the concrete appears to be superimposed on a visible steel structure, because public opinion has not had time to rid itself of the idea, possibly quite sub-conscious, that a bridge may be of steel, or of concrete or masonry, but not of both. A couple of generations may well pass before the new Waterloo Bridge will provide as much æsthetic satisfaction to the ordinary thoughtful passer-by as did the old Waterloo Bridge to his predecessor of the Nineteenth Century.

It would seem that the approach to this subject can only be by the critical analysis of existing structures and machines and industrial plants, to ascertain which of their features compel admiration in the beholder and which merely cause irritation or excite active disapproval. There is already evident a growing appreciation of the fact, of which the Greeks in particular seem to have been so acutely conscious, that beauty lies in line and proportion and not in adornment; and this essential principle, we would suggest, might well be made the subject of a lecture, or a short course, at the outset. That there has been a definite improvement in this respect can be readily seen by comparing typical public buildings of 30 years ago with the acknowledged best of to-day; but, in avoiding the irritation of superfluous ornament, designers have not always realised that the absence of such distractions throws into greater prominence the general proportions of the structure as a whole. Questions of finance are certain to impose severe restrictions on post-war designers, with whom economy of material will be a primary consideration. It will behove them, therefore, to achieve their æsthetic effects incidentally, for there will be little money available for merely decorative purposes. The study of line and proportion offers the only real solution of this problem. Proportion itself, however, cannot be divorced from the properties of the materials employed, and no small part of the task before the lecturers in this somewhat controversial field must be that of moulding the public sense of what are true proportions to the properties of the new materials, and the new combinations of them, that scientific research now places at the disposal of the engineer and the architect.

EDUCATION AFTER THE WAR.

To a large extent the various speeches and articles which are now being devoted to the subject of education after the war are necessarily of a highly speculative nature. Those who deal with the subject usually foretell very extensive changes, which they always describe as reforms, while a proportion appear to suggest that the whole of our present educational system is in a thoroughly unsatisfactory state. It is natural to try to look beyond the dust and clamour of these evil days to an era in which new progress in the paths of peace can be made, but it is unwise to deceive either oneself or others with ideas that are likely to be outside the bourne of possibility. Education for many years has been a heavy and growing item in national expenditure, and apart from any other consideration our procedure after the war will be conditioned by the financial position in which we find ourselves. This cannot now be forecast.

Mr. Ramsbotham, President of the Board of Education, speaking to the London branch of the National Union of Teachers, on May 12, said that after the war three main lines of educational advance would be undertaken as soon as possible. These were:—The raising of the school-leaving age to 15; the establishment of day continuation schools; and the reform and expansion of the secondary school system, so that a secondary education of a type suitable to their varying capacities should be available for every child from the age of eleven. These two latter items are expressed, no doubt deliberately, in such general terms that, as they stand, they do not call for criticism and hardly for comment. As, however, earlier in his speech Mr. Ramsbotham suggested that our future educational programme would be "conceived on bold and generous lines," it may be assumed that those now concerned with the administration of education have prepared at least an outline of future procedure.

Like much else, education could be better than it is, but ultimate disappointment is likely to await those who suppose that changes in the structure of our educational system will bring to light great stores of native talent now being wasted owing to lack of opportunity. Even now, no promising pupil need look far to find assistance in pursuing his educational career. This is illustrated by the facts that at Oxford and Cambridge half, or more than half, of the undergraduates are being assisted by some type of scholarship or grant, and that, at the other end of the scale, various educational institutions recruited from the primary schools have great difficulty in finding sufficient suitable scholars to fill all the places which they have to offer.

Discussion of any general and far-reaching changes in educational procedure may well be left until concrete proposals have been put forward. It is the first item in Mr. Ramsbotham's programme to which we desire more particularly to refer. In this he departs from generalities. The raising of the school-leaving age is a definite step which may be approved or disapproved, but about which there can be no misunderstanding. In view of the many years during which this matter has been under discussion and the wide approval which it has evoked, it is highly probable that it will be carried through no matter what may be the complexion of the Government then in being, which, incidentally, is not yet settled. The extra year of schooling which children will obtain under that regime may have valuable reactions over the whole educational field.

Mr. Ramsbotham's reference to the reform of the secondary school system presumably had some relation to the longer educational period which will be available, and it is to be hoped that any changes which are made will aim at utilising the extra year in a way likely to be of benefit to the scholars and the country. Most children pass from school into commerce or some kind of trade, and at the age of 15, in many cases have some idea of what their future sphere will be. To make the extra year of schooling to some extent of a vocational nature would not only benefit the State owing to an influx of better prepared future workers, but would increase the interest of the children so that they would obtain increased benefit from the instruction. This aspect of the matter was referred to by Mr. S. H. Moorfield in his presidential address to the 32nd annual conference of the Association of Teachers in Technical Institutions, on May 31. Pointing out that as many children will have set their heart on some profession or occupation, he allowed himself to go as far as to say that "the school life will be an unhappy one if the course of study is not given a vocational flavour." Mr. Moorfield is an A.M.I.Mech.E., and is connected with the Mining and Technical College, Wigan, so that in speaking of vocational training he probably had in mind the same vocation that interests most readers of this journal. He spoke of the excellent results shown by the junior technical schools and commended what was called the technical high school in the Spens report.

That report dealt with secondary education and recommended three types of secondary school, of which the technical high school was one. Mr. Moorfield did not mention in his address the subject of ages of entry, but as he stated that the technical high school should lead naturally to the applied science departments of the Universities, or to senior courses in technical colleges, it may be presumed that he does not contemplate that the leaving age from the technical high schools would be the same as the future leaving age from primary schools. It is probable that he would rather look upon the latter as the age of entry. This, however, so far from weakening the value of a vocational twist at the end of primary schooling, has the opposite effect. Recruits to the technical high schools will be more valuable if their interests and abilities have been exercised on the elements of the subjects they are to pursue.

Mr. Ramsbotham spoke of a secondary education of every child from the age of eleven. Mr. Moorfield, dealing with technical training, was naturally not concerned with every child, but when he spoke of the technical high school as the gateway to the university he clearly did not refer even to every child who intends to follow an engineering career. The majority will not pass to any university; they will pass to the workshops, and it is from the point of view of the majority and of the workshops, it is to be hoped, that effort will be made to utilise the extra year of schooling to the best advantage. Most firms that have properly developed and administered apprenticeship systems have different grades into which the apprentices are divided, ranging from those who are being educated for work in the shops to those who, having previously obtained an engineering degree or diploma, are destined for the higher administrative or technical posts.

The British Thomson-Houston Company may be cited as an example of a firm following this practice. Their scheme covers three main grades, trade apprentices, engineering apprentices and student apprentices. It is with the former that we are more concerned. The age of apprenticeship starts at 16 and the boys, in general, enter from the primary schools. They are usually engaged for one year as office or utility boys in one of the office or works departments before beginning their apprenticeship. During this preliminary period they obtain some idea of life in a big industrial concern and are able to start on their proper technical career having already settled down into the routine of works life. It is clear that if these boys could enter with some preliminary preparation received in the last year of school life they would not necessarily be able to dispense with this first probationary year of works life, but would be in a position to benefit from it in a way that one without any technical knowledge cannot do.

The value of such early training was emphasised by Dr. A. P. M. Fleming in his presidential address to Section L of the British Association in 1939. Speaking of another works, he said that while 64 per cent. of entrants from elementary schools became artisans less than 10 per cent. of those from Junior Technical Schools did so. As the main purpose of trade apprentice systems is to train artisans it is not an advantage to a firm that too many of those educated under them should pass to other grades of work, but the comparative figures clearly illustrate the value of early vocational training.

NOTES.

ELECTRICITY SUPPLY FINANCE.

THE recent judgement of the High Court in the case brought by the South Wales Electric Power Company against the Electricity Commissioners is of much importance. One of the main duties of the Commissioners is to examine applications for extensions of plant capacity or for the construction of new stations which may be put forward by electricity supply authorities, and to determine whether they are technically sound and will form useful or necessary additions to the power-supply capacity of the country. About a year ago the South Wales Electric Power Company advanced proposals, the carrying out of which necessitated the increase of its share capital by 1,000,000*l*. The proposals were accepted by the Commissioners, but before giving assent to them they made it a condition that the method on which the new capital was to be raised should also be submitted for their approval. We understand that arguments on the same matter have taken place between the Commissioners and other undertakers in the past. The South Wales Electric Power Company, however, refused to submit and decided to test the matter in Court. As a result it has been ruled that the Commissioners were acting entirely outside their powers in attempting to control capital issue by public companies. The Electricity Commission is a technical body, and although we believe the present chairman is not a technical man, Sir John Snell, the first chairman, who controlled its proceedings for so many years, certainly was. Its powers are defined in the Act of 1919 by which it was created and these, as the High Court has now affirmed, certainly do not cover the control of the issue of capital by private or public companies engaged in electricity supply; that is the function of their directors.

THE CHIEF MECHANICAL ENGINEERS' DEPARTMENT, L.N.E.R.

In our issue of May 2 it was recorded that Mr. E. Thompson, O.B.E., had been appointed chief mechanical engineer of the London and North Eastern Railway, in succession to the late Sir Nigel Gresley, C.B.E. We are now advised that a number of important changes have been made in the organisation of Mr. Thompson's department, the head office of which is to be at Doncaster. A new post of assistant chief mechanical engineer has been created, the first occupant of which is Mr. A. H. Peppercorn, hitherto mechanical engineer for the North-Eastern Area. Mr. Peppercorn is responsible for the work of the department in any temporary absence of Mr. Thompson, and will also act as mechanical engineer, Doncaster, with control of the carriage and wagon works at York and supervision of all "outdoor" carriage and wagon work on the Great Northern section, and on the Great Central section between Sheffield and London. Under the new organisation there are five mechanical engineers, namely, Mr. Peppercorn (Doncaster), as stated above; Mr. F. W. Carr (Stratford), Mr. R. A. Smeddle (Darlington), Mr. J. F. Harrison (Gorton), and Mr. T. E. Heywood (Scotland). Mr. Heywood's headquarters are at Cowlairs, where he will be assisted by Mr. K. S. Robertson, who has been appointed assistant mechanical engineer (Scotland). Mr. Heywood and Mr. Carr are continuing in the positions which they held previously. Mr. Smeddle, whose duties now include control of the shops at North Road, Faverdale, Shildon and Walker Gate, was formerly locomotive works manager at Darlington, where he has been succeeded by Mr. L. Reeves. Mr. Harrison had been works manager at Gorton, a post which has now been taken by Mr. H. J. Williams, formerly chief material inspector at Doncaster. Mr. D. R. Edge will continue to act as assistant to the chief mechanical engineer in technical matters, and Mr. H. Harper, who remains in charge of the headquarters' office of the department, receives the title of assistant to the chief mechanical engineer (clerical). Mr. J. V. Gosling joins the headquarters' staff as chief clerk. Certain drawing-office changes have also been made. Mr. E. Windle has been appointed chief draughtsman, with charge of the locomotive, carriage and wagon drawing offices; Mr. F. Day remains in his present position as head carriage draughtsman; and Mr. D. D. Gray becomes chief locomotive draughtsman in place of Mr. T. A. Street, who has been transferred to the department of the chief electrical engineer.

THE INSTITUTION OF GAS ENGINEERS.

The 78th annual general meeting of the Institution of Gas Engineers was held at the Institution of Mechanical Engineers on June 11, when the chair was occupied by the President, Mr. George Dixon, B.Eng., M.Inst.C.E. It may be recalled that, owing to developments in the international situation, the 77th annual general meeting, which was to have been held in London on June 4 and 5, 1940, was postponed and finally cancelled. Hence both the 77th and the 78th annual reports of the Council and statements of accounts were presented at last Wednesday's meeting. The 78th report showed that there were 1,772 members on the roll of the Institution on December 31, 1940, as compared with 1,751 on December 31, 1939. The papers which were to have been presented and discussed at the annual general meeting and at the Autumn Research Meeting in 1940, which also was not held, were published and made available to members, and written comments thereon invited. Twelve diplomas in gas engineering (manufacture) had been awarded in 1940, but no diplomas were awarded in gas engineering (supply). The Institution continued to exercise its usual professional, technical and educational functions, modified where necessary in accordance with war-time requirements. It maintained close collaboration, either directly or through the Gas Research Board, with Government departments, in order that the technical information and resources of the gas industry might be at all times at the disposal of the Government. The accounts showed that the income of the Institution for the year ending December 31, 1940, was 5,705*l*., and that the surplus of income over expenditure was 1,560*l*. After the presentation of the Institution Gold, Silver and Bronze Medals for 1940, Mr. Dixon delivered his presidential address. The annual meeting was then adjourned for a meeting of the contributors of the Benevolent Fund to be held. In the course of this meeting, it was reported that the number of cases assisted by the Fund, in 1940, was 29, and that the sum expended was 956*l*. 10*s*., as compared with 923*l*. 6*s*. spent in relieving 26 cases in 1939. It was further pointed out that the estimated income for 1941-42 was 1,950*l*., and that the committed expenditure was 1,100*l*. An appeal was made, therefore, for increased support. The remainder of the morning and the whole of the afternoon were devoted to the presentation and discussion of a symposium of nine short papers on "The Gas Industry: 1941 and After." We commence to reprint abstracts of these papers on page 475 of the present issue. After a vote of thanks to the authors of papers and to the officers had been passed, a final vote of thanks was accorded to the President, to whom a presidential certificate was presented.

ANTONIO PACINOTTI, 1841–1912.

In our issues of March 15 and 22, 1940, on pages 274 and 314, respectively, there were two articles in which reference was made to two pioneers in electricity generation, namely, the Danish electrician Sören Hjorth (1801–70) and the Hungarian physicist, Ányos Jedlik (1800–95). As pointed out by Mr. W. T. O'Dea, whose paper "Electrical Invention and Reinvention," read to the Newcomen Society on March 13, 1940, was summarised in the second of the above articles, both of these workers independently made important proposals for self-exciting electric machines, Hjorth in 1855 and Jedlik in 1861. To-day we are reminded of another pioneer, the Italian physicist Antonio Pacinotti, the centenary of whose birth falls on June 17. Born at Pisa, where his father held the University chair of physics, Pacinotti quite early became interested in electro-magnetic problems, and it is said that it was while he was a youth of eighteen serving in the Garibaldean army, he planned the construction of his electric machine with the ring armature. In the Science Museum there is an example of a Pacinotti machine, made while the inventor was still in his 'teens. This machine has an armature core of a toothed wheel of iron between the teeth of which the coils are wound in 16 separate sections. The coils are joined in a closed circuit and connections are brought from 16 points to the commutator, which is mounted on the vertical spindle above the armature. The methods of winding and commutation which are adopted result in a current which is almost steady. A machine similar to this one was described by Pacinotti in the Pisa journal *Il Nuovo Cimento* of May 3, 1865. His work, it will thus be seen, was done slightly before the still more important work of Wilde, the Varleys, Wheatstone and Werner von Siemens, and, though Pacinotti afterwards devised other types of dynamo, it is on account of his early work that he is chiefly remembered. After his term of service as a sergeant in the Tuscan division of engineers under Garibaldi, Pacinotti was made assistant astronomer at Pisa at the age of twenty-one, and then successively held chairs of physics at Bologna (1864), Cagliari, in Sardinia (1873), and at Pisa (1882), where he returned after his father's death. From his own countrymen he received many marks of distinction and in 1902 the Institution of Electrical Engineers elected him an honorary member. He died at Pisa on March 25, 1912, at the age of seventy. In 1934, the Italian nation, when commemorating the anniversary of their entry into the Great War on the side of the Allies, also commemorated the 75th anniversary of Pacinotti's invention. On this occasion an exhibition of Pacinotti relics and manuscripts was held, orations were given, and a commemorative tablet was unveiled on the house in which he was born and died. The commemoration was preceded by the publication of a work on his life and labours, by Professor Polvani of Milan University.

WAR DAMAGE TO PUBLIC UTILITIES.

It is stated in *The Times* that the difficult case of compensation for war damage to public utilities will be met by the introduction of special legislation. Under the scheme, which will be administered by the War Damage Commission, the aggregate contributions of the members of each group of public utility undertakings will be half of the estimated aggregate war damage payable to the members of the group. The contributions will be payable in four annual instalments, starting on July 1, 1942. Adjustments will be made, from time to time, as may be found necessary by the results of successive estimates of damage, and the War Damage Commission will have power to recommend the reduction of the 50 per cent. contribution by any, or all, of the groups, having regard to the relative amount of damage suffered. The aggregate contribution due from any group will be divided in accordance with a scheme made by them and approved by the Treasury. When damage can be made good by repair, the payment which will be made to an undertaking under the scheme will be equivalent to the actual outlay, but will not cover increased outlay due to the introduction of improvements. For damage beyond repair, the payment will cover replacement, less a sum representing obsolescence of the old asset. If a structure damaged beyond repair is not replaced by one of similar character and size, compensation will be a sum, determined by the War Damage Commission, not exceeding the actual outlay. When an asset is not replaced at all, a value payment will be made. The proposals refer to the first risk period ending on August 31, 1941.

REPAIR OF DAMAGED MACHINE TOOLS.

From their very nature, few machine tools can be irretrievably damaged by enemy action in the form of bombing; some even only call for re-conditioning, but there should be the least possible delay in repairing such machines. In normal times, the natural process is to send back a machine tool calling for rehabilitation to its original makers, but the necessary transport to-day is, generally, not available, while the manufacturers are usually fully occupied with the production of new tools. The Department of Machine Tool Control, under Mr. P. H. Mills, has, therefore, initiated an organisation to deal with machine tools damaged by enemy action. Briefly, this consists of the division of the

country into a number of areas, each including several counties and administered, as regards damaged machine tools, by the chairman of the Local Reconstruction Panel, and a Machine Tool Control Area Officer. In each area, also, is what is known as a "leader firm," that is, a firm taking under its supervision a group of firms which may have tools and men available from time to time, but which do not normally undertake repairs to machine tools. Should a works be damaged, the casualty firm will be assisted in arranging for the clearance of the debris and for inspection of damaged machine tools. These are then taken over by the nearest suitable leader firm, who will either carry out the repairs themselves or allocate the machines to the group members. Should machines be so seriously damaged that repair would take a long time, or be beyond repair, the Machine Tool Control should be able to arrange for the allocation of suitable machines in their place. Firms who are prepared to assist the national effort either as regular members of a group, or in an emergency only, should get into touch with the Machine Tool Control Officer in their area offering their services. A full list of the areas and officers is given in supplement to the issue for March/April of *British Machine Tool Engineering*, published by Messrs. Associated British Machine Tool Makers, Limited, at present of the Manor House, Claygate, Esher, Surrey.

STANDARDISATION OF BRICKS.

The announcement is made by the Ministry of Works and Buildings that an agreement has been reached with brick manufacturers throughout England and Wales to standardise only two sizes of brick in order to facilitate bulk production. A committee, representative of the makers and users of bricks and working in conjunction with the British Standards Institution, agreed on standard sizes as long ago as 1936, and these standards were adopted by the London Brick Company, the whole of the Fletton makers, and by a large number of other manufacturers. Certain others, however, continued to work to the different sizes which had become established in particular districts by local usage of long standing; in all, there were 17 sizes, which introduced difficulties on big Government constructional works, where the bricks used were drawn from a number of brickyards in various parts of the country. The sizes now standardised are similar in length and width, but differ by $\frac{1}{4}$ in. in depth. The length is $8\frac{3}{4}$ in., with a tolerance of $\pm \frac{1}{8}$ in., and the width is $4\frac{1}{16}$ in., $\pm \frac{1}{16}$. The depths of the two types are $2\frac{1}{8}$ in. and $2\frac{5}{8}$ in., respectively, with a tolerance of $\pm \frac{1}{16}$ in each case. They are known as Type II and Type III. Type I is a facing brick, the production of which is apparently to be suspended during the war. There are in England and Wales some 850 brickmakers, whose annual output amounts to about 5,000 million bricks. Most of these firms were working already to the agreed standards, and the small minority are now altering their plant to conform. The Ministry of Works requests, therefore, that users of bricks for any purpose whatever, in England and Wales, will work to these standards. Any necessary re-arrangement to enable this to be done should be put in hand at once, to avoid further hampering of the manufacturers by demands for sizes now obsolete.

LETTER TO THE EDITOR.

THE QUADRATURE BOOSTER FOR LONG-DISTANCE POWER TRANSMISSION.

TO THE EDITOR OF ENGINEERING.

SIR,—In his article in your issue of May 23, page 402, Mr. Kipps gives, by implication, an exposition of the fallacy of the Taylor booster. The problem of compensating a long line has two aspects: in the first place it is necessary to relieve the alternators of the wattless power, either reactive or capacitative, of the line in order to reduce the losses and maintain stability of their excitation; in the second to maintain transmission stability, both static and dynamic. The leading wattless power corresponding to the electrostatic capacity of the line increases as the square of the voltage, while the lagging wattless power corresponding to its inductance increases as the square of the current. Thus if the power transmitted at constant voltage is increased progressively from zero, the net wattless power is first of all capacitative, then passes through zero at the "natural load," and finally becomes reactive.

Under any conditions other than those of natural load, therefore, it is necessary to supply reactive or capacitative current to the line at a rate which varies with the load. The usual methods of doing this include synchronous condensers, the excitation of which may be varied in accordance with the load on the line, and static reactors and condensers which may be switched in and out in a similar manner. It is clear from Mr. Kipps' article that the Taylor booster could not serve for this purpose, as it shifts the phase of both current and voltage by the same amount. Mr. Kipps seems to confirm this view by saying that the Taylor booster "can be utilised to neutralise the angular displacement of a system working at neutral load." Even if it is assumed that the wattless power of the line is completely compensated there remains the problem of stability.

Under given load conditions the current and voltage at the receiving end both lag behind the current and voltage at the transmitting end. As the load increases this angle increases, but the percentage increase of load for a given percentage increase of angle decreases as the angle increases until, at a certain limit, a further increase of the angle results in a decrease of the load transmitted, and the transmission thus becomes unstable. It follows that merely to shift the angle by a fixed amount, which, as Mr. Kipps explains, is the result achieved by the Taylor booster, can have no effect at all, either upon the static or dynamic stability. The effect of the Taylor booster is very nearly the same as could be produced by mechanically shifting the couplings between the alternators and turbines by a fixed angle or by installing a suitably connected transformer at either end of the line.

Yours faithfully,
C. J. O. GARRARD.

22, Knighton Close,
Four Oaks, Warwickshire.
June 4, 1941.

CORROSION OF SURFACES IN CONTACT.

ALTHOUGH a very thorough experimental investigation of the mutual corrosion of metal surfaces in closely-fitting contact when subject to vibration has been made, it cannot be maintained that the problem has been completely solved. The experiments referred to above were described in a paper read before the Institution of Mechanical Engineers by Dr. G. A. Tomlinson, Mr. P. L. Thorpe and Dr. H. J. Gough, entitled "An Investigation of the Fretting Corrosion of Closely-Fitting Surfaces." The paper was reprinted, in abridged form, in ENGINEERING, vol. 147, page 293 (1939), and, while possible causes of the trouble were suggested in it, no definite conclusion was reached and no certain remedy indicated. The same uncertainty was evident from the views expressed by the speakers in the discussions following the reading of the paper in London and at its subsequent presentation before the North Western Branch in Manchester. Our attention has been drawn recently to what appears to be a case of fretting corrosion in cotton-spinning mills. The comments of our correspondent, Mr. Fred Rushton, of Bolton, are summarised below and form, to some extent, an addendum to the discussions on the paper.

The surfaces concerned are those between the driving shafts and the pulleys on them in cotton-spinning mules. In the mill in which the observations were made there are 64 pairs of mules, each mule having its own driving shaft, and the firm adopts a policy regarding overhaul involving examination at intervals which are approximately one-third of those commonly adopted in the industry. It was this frequency of overhaul that brought the defect into prominence, since it meant that, for a period of some $3\frac{1}{2}$ years, it was becoming evident at intervals of ten days on the average. The defect is, of course, noticeable when the longer overhaul intervals are employed, but is apparently accepted as unavoidable. However, such frequently recurring trouble as is indicated above served to emphasise its importance and Mr. Rushton accumulated data regarding its cause and arrest for the ten years preceding the outbreak of the present war.

The defect consisted of the corrosion of the shaft in way of the pulley boss to such an extent that it was considered unwise to replace the shaft, a new shaft having to be provided and the pulley boss bored and fitted with a bush to suit. The first conclusion reached was that the pulleys were such a bad fit on the shaft that substances likely to set up oxidation were able to creep along axially and lodge between the two surfaces. It will be realised that the atmosphere in which cotton-spinning mules have to work is warm and moist. The most suitable temperature, according to one authority, is between 70 deg. F. and 90 deg. F., although these figures are often exceeded. According to the same authority, the best conditions of relative humidity appear to be from 48 per cent. to 53 per cent. It would seem, then, at first sight, that the conditions are extremely favourable to ordinary corrosion if a gap existed between the pulley and shaft. The shafting and pulleys had been installed, however, by a thoroughly reputable firm, so it was extremely unlikely that loose fits were present, and no badly-running or out-of-balance pulleys could be detected. In support of this assumption it was found that the pulleys were so tight on the shafts that, in order to remove them, they had to be driven forcibly along the whole length of the shaft and that a complete seal of the joint existed in the form of a rubber-like deposit resulting from the constant wiping of the shaft surface.

An investigation was then made to find out if the conditions under which the shafts and pulleys had been originally assembled might have initiated the defect. The shafts were not scored or marked in an axial direction, which would have indicated that the pulleys had been driven on to them in a dry condition. It was safe to assume, therefore, that a mineral oil had been used to enable the pulleys to be got into place. The fit between the two parts being very close, it was then inferred that this, in conjunction with a humid atmosphere, would result in the dissociation of the oil, so that a minute deposit of mineral matter might be made and attack the surfaces and cause the corrosion. In addition, cast iron, when exposed to moderate heat and excessive humidity for two years or more, is known to become spongy in texture. This porosity, while not affecting the tensile strength of the metal, might permit moisture to reach the surface of the shaft since this was no longer protected by an oil film and such moisture would increase the corrosive effect of the deposits. Negative evidence in support of this theory was provided by the fact that in some of the shafting in the same installation, chiefly line shafting, the pulleys are secured by split conical bushes and not by keys. In assembling these pulleys and shafts, no oil would be necessary to fit the bushes and there is no sign of corrosion between the pulley and shaft when taken apart.

The logical assumption was then made that the use of mineral oil as a temporary lubricant for assembling shafts and pulleys was incorrect, and when installing a replace shaft, either tallow or mutton fat was substituted. Both these lubricants seem to have been satisfactory, for in the eight or nine years during which they have been employed no deterioration of the surface has been observed when the parts were stripped for subsequent overhauls. Although in the paper and discussions above referred to the influence of oil on fretting corrosion was considered, it would appear that only ordinary machine oils and castor oil, with some proprietary greases, were used. The employment of animal fat, as described above, is suggestive at least, and seeing that it has been employed for so long in actual practice with satisfactory results, the matter seems worthy of recording here. The possible effects of fitting a bush in the re-bored pulleys must not, of course, be excluded.

THE INSTITUTION OF GAS ENGINEERS.

THE annual summer meeting of the Institution of Gas Engineers was restricted this year to one day, and was held at the Institution of Mechanical Engineers, London, S.W.1, on Wednesday, June 11. On account of the special conditions now ruling in the gas industry, it was decided to present nine short papers, written by selected authors, covering the practice and policy of the gas industry in 1941 and after. The papers thus had a strong flavour of post-war reconstruction.

STANDARDISATION OF CALORIFIC VALUE.

The first paper was contributed by Sir Frederick J. West, C.B.E., M.Inst.C.E. (honorary member), chairman and managing director of Messrs. West's Gas Improvement Company, Limited, Manchester, and senior vice-president of the Institution, and was entitled "The Standardisation of the Declared Calorific Value." The author pointed out that the Gas Regulation Act of 1920 enabled each individual gas undertaking to select whatever standard of calorific value was best suited to its own local conditions. The standard so selected, of course, had to be rigorously maintained. As a result of this freedom there were no less than 26 declared calorific values, ranging between 200 B.Th.U. and 600 B.Th.U. per cubic foot. Of the 654 gas undertakings that worked to declared standards, manufacturing in all some 303,000 million cub. ft. per annum, 219 operated at 500 B.Th.U., 143 between 470 B.Th.U. and 480 B.Th.U., and 192 between 450 B.Th.U. and 460 B.Th.U. Only two undertakings were below 400 B.Th.U., and only 16 above 500 B.Th.U., though this latter number included the important South Metropolitan Gas Company. The choice of a declared calorific value depended upon the properties of the coal available and the characteristics of the plant employed. A desired decrease in the calorific value might be prevented by the inadequate capacity of the existing distribution mains for taking the larger volume of gas that would be required.

Sir Frederick West maintained that the policy of the gas industry should be to provide the maximum of refined fuel in the gaseous form, coke being regarded as a by-product. The lower the declared calorific value, the higher would be the gaseous thermal yield per ton of coal carbonised; save in exceptional market conditions for coke, the therms at 450 B.Th.U. could be sold more cheaply than those at 500 B.Th.U. By far the best means of achieving the abolition of smoke was by the sale of gaseous therms at a low price. For these reasons, the gas industry should retain its freedom of choice in the standards to which it supplied gas. Nevertheless, a modified form of standardisation was to be advocated for several reasons:—(1) a multiplicity of calorific values confused the public mind, which had never become quite used to the therm method of charging for gas, as a quantity of heat obtained for a given payment; (2) diversity of standards gave rise to difficulty in the design of burners for gas appliances; although combustion characteristics should also be standardised to avoid these difficultues, it would appear that standardisation of calorific value would be a big step in this direction; (3) interchange of gas between neighbouring undertakings, and amalgamation of undertakings, would be simplified by a reduction in the number of standards. The views of several authorities were quoted in support of the conclusion that standardisation is desirable. Sir Frederick West's conclusion was that, although one standard for the whole country might be inadvisable, four values, namely, 500, 475, 450 and 425, should suffice to meet all, or nearly all, requirements. If benzole washing was to be a permanent and practically universal feature of gas manufacture, and particularly if it was carried to the point of reducing effectively the organic sulphur content of the gas sold, it would be advisable to adopt a declared value 25 B.Th.U. lower than the standard which would be otherwise adopted.

SULPHUR CONTENT OF TOWN GAS.

The second paper, on the subject of "Sulphur Reduction as a Future Requirement in Town Gas," was contributed by Dr. Harold Hartley (member), technical director and head of the research department, Radiation, Limited, Birmingham. Dr. Hartley pointed out that, so long ago as 1914, Dr. Charles Carpenter had advocated the elimination of carbon disulphide from town gas, in addition to the already compulsory complete elimination of H_2S, in order to obtain gas of a very low sulphur content. In that lecture, Dr. Carpenter introduced a new method of sulphur extraction worked out by the South Metropolitan Gas Company, which brought the sulphur content of the purified gas to 8 grains per 100 cubic feet, at an additional cost of 0·3*d.* per 1,000 cubic feet, or 0·05*d.* per therm. For 20 years nothing was done in this direction by the industry generally, but by 1933 those on the gas utilisation side of the industry began to press strongly for sulphur removal. In November, 1936, it was announced by H. Hollins and E. V. Evans, in a report to the Autumn Research Meeting of the Institution,* that processes existed and new processes had been devised by which the sulphur content of town gas could be reduced below 10 grains per 100 cubic feet, and that virtually complete removal from town gas could be obtained by a combination of these processes and by a modification of the active-carbon process for benzole extraction. It was recommended that there should be an immediate all-round reduction of the sulphur content of town gas to 10 grains per 100 cubic feet.

The reasons put forward by the author in favour of this reduction in sulphur were:—(1) to encourage the introduction of flueless heaters, which, when used with proper discretion, provided a very efficient and convenient method of utilising gas for room heating, but one which was adversely affected by the smell of sulphur oxides in the products of combustion unless the sulphur content of the gas was very low or the room was exceedingly well ventilated; (2) to reduce the cost of maintenance of gas appliances. Figures were given from the experience of the Birmingham Corporation Gas Department, which suggested that the maintenance cost for appliances amounted to 4*s.* 2*d.* per domestic consumer per annum, which, assuming an average annual domestic consumption of 100 therms, amounted to a maintenance cost of 0·05*d.* per therm. Research by the Institution had shown that corrosion of appliances decreased as sulphur was removed; and the author concluded that it would not be unreasonable to expect a saving in the cost of maintaining appliances and of dealing with complaints of 0·1*d.* per therm sold to domestic consumers if sulphur were eliminated.

STANDARDISATION OF COKE.

Mr. W. L. Boon, M.I.Mech.E. (associate), general manager of the London and Counties Coke Association, contributed the next paper, which was entitled "The Standardisation of Coke Grades and Properties." The class and quality of coal used in the process of carbonisation, he observed, exercised such material influence on the quality of the coke produced that there would appear at first sight to be no prospect of approaching with any degree of success any problem of standardisation while restrictions on the choice of coals were imposed. Although the subject of the paper was thus more nearly related to peace-time conditions than to those of war, the author felt that useful work might be done towards standardisation which would be of considerable benefit to the gas industry's post-war coke business. After the war, the consumer would be more critical and would select his fuels with greater care, so that there was need to take thought in time if the coke business was to be retained. Gas coke was used for six major purposes: (1) domestic hot-water supply; (2) domestic open fires; (3) central heating; (4) steam raising; (5) producer-gas plants; and (6) breeze. There would be no great difficulty in developing standards to cover all these branches of coke utilisation, and in doing this there would have to be taken into consideration the relative importance of such factors as uniformity of size, ignitability, combustibility, ash (content and volume), bulk density, and reactivity to carbon dioxide. The author considered, however, that most of these factors could not be standardised under present conditions, but that size grading, the factor which exerted the greatest influence in the successful use of most gas cokes, could be so standardised forthwith.

The London and Counties Coke Association had laid down standard sizes for coke which had been found to cover adequately the requirements of a total production approaching 4,000,000 tons per annum, and had proved highly advantageous both for the consumer and the producer. It was believed that standards identical with those in operation for gas coke could have been applied equally well to furnace coke, because these standards were laid down within limits which within themselves permitted an elasticity of size, so as to allow for differences in coke characteristics. The author viewed the future solid fuel business in this country as progressively tending to the greater use of carbonised fuels, and thought that a practical form of standardisation must sooner or later be applied. It had been recently agreed, after examination of the problem, that of the 300 odd sizes produced by the coal industry, only about 25 were necessary.

STANDARDISATION OF GAS APPLIANCES.

A short paper, entitled "The Standardisation of Consumers' Appliances as a Post-War Policy," was contributed by Mr. R. J. Rogers (member), managing director of the Parkinson Stove Company, Limited, Stechford, Birmingham, with the object of focusing attention on features of gas-appliance design, and on some of the directions in which appliances might be developed with a view to the rehabilitation and advancement of gas sales in the post-war reconstruction period. The domestic load was the back-bone of the gas industry, the author stated, and he considered that, after the war, the public's cash resources would be only sufficient for the purchase of essentials. The gas industry must design its appliances accordingly, to provide attractive propositions for the further extension of home comforts that would compete with similar inducements from competing interests. Domestic gas appliances were vital factors influencing the standard of living; they were not luxuries, but were absolutely essential for the cooking of food, the provision of hot water and the maintenance of comfortable warmth. The reconstruction that would be necessary after the war was likely to lead to the standardisation of most components of house construction, and the gas-appliance industry must consider to what degree standardisation was practicable.

Mr. Rogers did not believe that complete standardisation would be desirable, because it might destroy the incentive to further progress; it would eliminate freedom of choice, and there would be difficulty in obtaining the agreement of manufacturers to this course and in reconciling the divergent views of gas undertakings. He believed, however, that the form of standardisation which would prove of most value involved the avoidance, in a given design, of individual desires for slight modifications. His views were summarised in the table herewith.

CLASSIFICATION OF GAS-APPLIANCE COMPONENTS.

Items in which standardisation presents great advantages and practically no disadvantages.	Items in which standardisation may present certain disadvantages.
Gas Cookers.	
1. Governors: Construction. Dimensions. Outlet pressures.	1. Taps.
2. Fixed Injectors: Dimensions. Method of indicating jet sizes. Calorific value ranges.	2. Burners: Boiling. Grilling. Oven. Methods of ignition.
3. Hot Plate: Height.	3. Top bars.
4. Oven Sizes: Four sizes suggested for domestic purposes.	4. Oven grids and gates: Cake-tray dimensions.
5. Flue spigot sizes.	5. Oven type: Side burners or single back burner. Top or bottom flue.
6. Thermostats: Temperat Uniform calibration and method of indication.	6. Thermostat: External design and method of mounting.
Gas Fires.	
1. Governor: Construction and dimensions. Outlet pressure.	1. Taps.
2. Fixed injectors: Dimensions. Method of indicating jet sizes. Calorific value ranges.	2. Burners: Automatic ignition devices.
3. Flue spigot size: Also height from floor level.	3. Radiants: or heating elements (for reflector-type fires).
4. Minimum performance.	
5. Overall dimensions.	

NOTE.—The particulars relating to gas fires given above apply equally to radiators and portable heaters as well as to water heaters, with the possible exception of overall dimensions.

The author advocated that a committee be set up, comprising representatives from the laboratories of gas-appliance manufacturers and representatives of gas undertakings, to consider the whole question of rational standardisation of appliances for post-war use. No time should be lost, however, by the industry as a whole in arriving at decisions concerning sizes, specifications, etc., as already appliances for post-war development were under consideration by many manufacturers. Finally, he advocated some standardisation of prices to avoid the differences in the prices charged by neighbouring gas undertakings for the same appliances. Universal standardisation of prices might not be practicable, but he urged that a scheme of rational standardisation should include at least regional standard prices for gas appliances.

INDUSTRIAL GAS.

The fifth paper in the series, dealing with "Post-War Development of Industrial Gas," was contributed by Mr. H. R. Hems (associate member), superintendent of the Industrial Heating Section, City of Birmingham Gas Department, who observed that the war of 1914-18 gave a great impetus to the use of gas for industrial purposes, and that the present war had given it a further equal impetus. The effect of the two wars had been to place industrial gas in a position which, probably, it never would have attained under the slow and difficult competitive conditions of peace, because of the difficulty with which manufacturers could then be persuaded to change their methods. It was necessary to plan for the future in order to retain this industrial gas load, and to be ready to meet the demands of industry. It was likely that factories would be set up

* See ENGINEERING, vol. 142, page 596 (1936).

in new districts and that many undertakings that hitherto had not been concerned in industrial gas supply would find it to be fundamental to their business. In any national fuel policy, the principle of "Back to Coal through Gas" which already was making considerable headway, would be of prime importance. There should be a survey of the whole field of industrial fuel application, since a balanced allocation of fuels would assist the nation's economic programme in peace time.

Dealing first with the price policy, the author asked if it would not be possible to adopt a more uniform price policy, particularly for certain processes which were common to the whole country. The advantages of increased load arising from the large individual consumptions should lead to the tariffs for industrial gas being brought to a level at which it would be in a better position to compete with other sources of fuel. On the development side, contact must be maintained with manufacturers in order to obtain first-hand information on changes of process or new processes which might affect existing gas-furnace practice, necessitating new technique in furnace development. Research into the application of gas to the new process might then have to be made by the gas industry, with the collaboration of the furnace maker, leading to revised and new designs of furnaces and appliances. The industrial gas centres already in existence must continue and their scope must be extended. Industrial gas engineers should become specialists in individual trades and processes, and an organisation should be set up whereby their services are available over a regional area as required. Increased speed of production and cleanliness of the product during heat-treatment processes were important modern developments for which gas was peculiarly suited. The development of suitable gaseous atmospheres in furnaces was also a useful application of town gas; the more so because liquid media for heat treatment were likely to be displaced in many operations by gaseous media. The recent work of the British Standards Institution on standard specifications for furnaces must be applied in the near future. The possibilities of improvement in efficiencies of the more ordinary types of furnaces, for which there would always be a demand, were by no means exhausted.

GROUPING OF GAS UNDERTAKINGS.

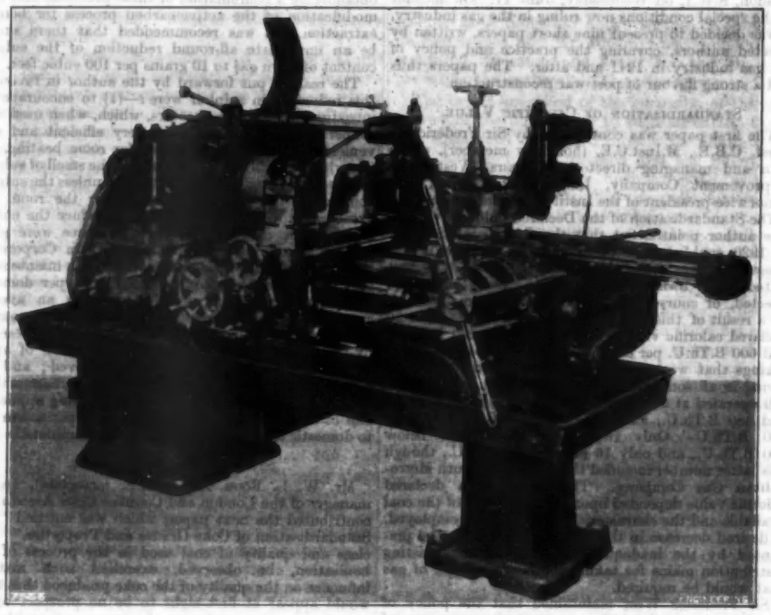
Colonel W. Moncrieff Carr, O.B.E. (member), managing director of the United Kingdom Gas Corporation, Limited, Manchester, contributed a paper on "The Future Grouping of Gas Undertakings," in which he pointed out that the gas industry came into being on a parochial basis, and that many factors had contributed to prevent amalgamations and grouping. There were, however, important reasons in favour of this policy, not the least important of which was the need for better distribution of the highly trained specialists in the industry. He declared that the day of the small undertaking, operating as a separately-controlled unit in a restricted area, had passed, and that the co-ordination and grouping of all such units must be a first consideration of the industry after the war. The industry must fight for proper recognition of the service and function it can fulfil; not operating, as it had done, with a multiplicity of small undertakings serving restricted areas with gas at relatively high prices, but amalgamated and grouped for the centralisation of manufacture in large and economic gas-making units, linked up to ring-main distribution systems, to ensure a supply of constant quality, purity and pressure. The greatest deterrent to grouping in the past had been a fear, on the part of local-authority committees, boards of directors, and managements, that their positions might be disturbed in a combined organisation. This was true in a measure with regard to the first two, but, in such grouping as had been carried out, the tendency generally had been to increase the scope of managements, and afford them wider opportunities for service and experience, both technical and administrative. It was desirable, he thought, that definite area plans should be formulated for the purpose of grouping undertakings.

Grouping had already been undertaken to some extent by the purchase of undertakings by holding companies, and by the acquisition of neighbouring small undertakings by their larger neighbours. The West Yorkshire Gas Distribution Company, with which he was associated, provided a third and unique method of grouping, this company being authorised to buy gas from coke ovens and gas undertakings connected to the system. Colonel Carr considered that there were many areas where a similar scheme might be put into operation and that, where coke-oven gas was available, it could, and should, be brought into the system. In dealing with the method by which a general grouping policy could be put into effect, he felt that the interests involved were so diverse that they could only be brought into line if a national scheme were prepared under the ægis of the appropriate Government department.

(To be continued.)

7¼-IN. CENTRE CAPSTAN LATHE.

MESSRS. WOODHOUSE AND MITCHELL, LIMITED, BRIGHOUSE.



7¼-IN. CENTRE CAPSTAN LATHE.

THE capstan lathe illustrated on this page is a new design by Messrs. Woodhouse and Mitchell, Limited, Brighouse, and is known as their No. 4 Capstan Lathe. With a centre height of 7¼ in. above the bed, and 4 in. over the cross-slide, the maximum distance between the capstan face and the spindle nose is 29 in., the capstan having a stroke of 11 in. The spindle is hollow, a hole 2½ in. in diameter through it admitting bars of a maximum diameter of 2 in. The bed is of box section with diagonally-disposed stiffening ribs and is carried on cabinet pedestals at each end, a pressed-steel cutting lubricant tray, provided with a filter and sump, being interposed between the pedestals and the bed feet. The drive is by a 5-h.p. constant-speed squirrel-cage motor through multiple Vee-belts adjustable for tension. The motor is suitable for 400 volt, three-phase, 50 cycle current, and is controlled by an automatic contactor-type starter with an isolating switch. The headstock is of the single pulley all-geared type. There are eight spindle speeds in each direction, with a range of from 30 r.p.m. to 750 r.p.m., the changes being effected by levers on top of the headstock. The vertical lever seen at the side of the headstock enables either a fast range of spindle speeds or a slow one to be selected. A positive interlocking device prevents two speeds from being engaged simultaneously.

The spindle, which has a flanged nose to suit chucks, etc., is carried at the front in Timken tapered-roller bearings, preloaded during assembly and mounted in pairs in a flanged sleeve, which enables the spindle and bearings to be withdrawn as a complete unit, should this be found necessary, without disturbing the adjustment. At the rear end, the spindle is carried in a ball bearing. Timken tapered-roller bearings are employed for all gear shafts, including the reverse idler gear and the intermediate gears on the spindle drive to the feed box. The sliding gears are carried on splined shafts. The gears themselves are made of heat-treated high-tensile steel and run in an oil bath. The speed changes, for both forward and reverse directions, are effected by disc-type and expanding-ring clutches. The feed box, seen at the base of the headstock, contains change gears enabling four speeds to be obtained in either direction and has a lead screw gear with a disengaging clutch. All the shafts and free-running gears in the feed box are mounted on anti-friction bearings and are immersed in oil.

The saddle is arranged for either automatic or hand-actuated turning and facing feeds. For automatic turning there are four feeds with a range of from 20 cuts to 80 cuts per inch, and for surfacing, four feeds with a range of from 40 cuts to 160 cuts per inch. The lead screw, for screw cutting, has speeds which give four pitches for each screw, having ratios of from 1 to 1, to 4 to 1. A quick withdrawal action for the tool is provided. Rotating stop bars, in conjunction with adjustable dead stops, provide automatic cut-out for both turning and surfacing motions. Power feed engagement when screw-cutting is prevented by an interlock device. If desired, a taper thread chasing attachment can be fitted. This device enables a maximum length of taper of 6½ in. to be dealt with, the maximum included angle being 40 deg. The tool quick-withdrawal gear is inoperative when taper threads are being chased. Another optional fitting is a bar-feeding device with collet chucks. The saddle cross-slide, which has both front and rear tool posts, is of steel.

The turret saddle, traversed along the bed by a capstan wheel, is secured in the desired position by effective locking clamps. Provision is made for maintaining alignment of the slide and for taking up wear. The turret is hexagonal with faces 4⅛ in. by 3⅛ in., and has tool holes 1½ in. in diameter. Tool boxes with overhead steadies are seen on two of the turret faces in the illustration. These are not, of course, permanent attachments. Adjustable automatic trips and dead stops, synchronised with the rotation of the turret, are provided. The saddle apron has a gear change which doubles the four speeds derived from the drive, so that eight rates of feed with a range of 40 cuts to 260 cuts per inch are obtainable in either the forward or reverse directions. The apron gears run in oil and the thrust is taken by anti-friction bearings. The turret can be hand-operated when desired.

SHORT-BREAK CARTRIDGE FUSES.

IN 1928 a short-break cartridge fuse was introduced by Messrs. W. T. Henley's Telegraph Works Company, Limited, Milton Court, Wescott, Dorking, Surrey, for use in underground disconnecting boxes. Since that time this type of fuse has been largely used, not only for the purpose for which it was originally intended, but also in overground pillars and other types of distribution equipment. Its internal design has been modified to render it suitable for the more exacting conditions which are now common and to ensure that it complies in all respects with the latest British Standard Specification (No. 88-1939). The most recent pattern of the fuse is illustrated in Figs 1 and 2, on the opposite page.

To ensure that rupture in a cartridge fuse only occurs at a suitable place, it is usual to reduce the cross-sectional area of the central portion of the fusible element, thus increasing the resistance at this point and causing it to reach a higher temperature. The result is that the working current more nearly approaches the fusing current. This is an advantage,

since for equal terminal temperatures, such a fuse will blow at a smaller overload current than a plain parallel element will. In the Henley fuse, the difference between the working and fusing currents is still further reduced by using a strip of alloy with a relatively high thermal resistance as the central portion. As a result, the conduction of heat from the fusible central portion, which has a high current carrying capacity, is reduced and it operates at a higher temperature than would otherwise be the case. Consequently, the element will fuse at a current fairly close to the working current without the temperature at the ends being increased above the normal value. When the central portion fuses at normal overloads, the junction between the central portion and the end stems remains intact. It is claimed that this construction is particularly advantageous where the fuse is embedded in a material with a thermal capacity that is low compared with that of the metal of the element, as the heat generated is restricted to the centre of the element with the result that the fuse can be designed to operate at a low working temperature and at the same time to have a fusing factor which is much lower than could otherwise be obtained.

An important constructional feature of the elements is that, in order to facilitate the dissipation of heat into the surrounding filling medium, part of each of the stems is cut and bent to form a lattice of "expanded metal," as shown at *a* in Fig. 2. Such an arrangement not only has a higher superficial area than a plain strip of the same cross-section, but is much less localised,

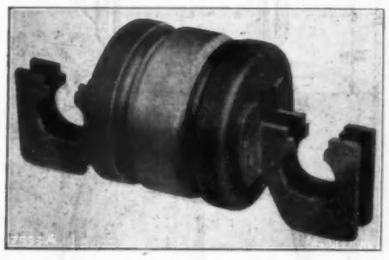
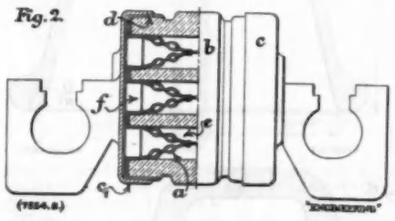


FIG. 1.

Fig. 2.



with the result that the medium surrounding each displaced portion of the strip is less affected by the remaining portions, and the transfer of heat from the stem to the medium is facilitated. Tests, in fact, show that while in a cartridge fuse fitted with plain strip the final steady temperature rise of the fuse cap was 51·5 deg. C., that of the fuse contact 44·2 deg. C., and that of the circuit terminal 31·5 deg. C., in the case of the fuse fitted with lattice stems the corresponding rises were 42·6 deg. C., 38·5 deg. C., and 27·6 deg. C. It will be appreciated that this reduction in temperature of the circuit terminals is particularly advantageous in boxes where parts of the contacts are close to or are embedded in insulating compounds.

The barrel of the fuse, *b* in Fig. 2, is of special ceramic material, and, after firing, its ends are precision ground to ensure a perfect bedding for the spun-on end caps, *c* and c_1. No cement is therefore necessary for securing the end caps, and that any loosening of the joint between the ceramic and the inner cap *d*, is therefore, obviated. A further advantage is that the spun-on construction enables the cartridges to be safely used in exposed positions. The inner cap is first forced into position and is then spun on to the ceramic barrel. The silver fusible elements are soldered to the cap. After the spaces *e* have been filled with silver, the ends of the separate channels are plugged with heat- and arc-resisting pads *f* and finally the outer cap, which carries the fuse contacts, is forced under heavy pressure over the inner cap and is soldered into position.

Tests conducted on these fuses at an official laboratory in Belgium, the results of which are reproduced in a booklet recently issued by the firm, show that they are capable of clearing a circuit satisfactorily when the current and power factors are adjusted in accordance with the British Standard Specification. Short-circuit and milli-volt drop tests showed equally satisfactory results.

LABOUR NOTES.

AGREEMENT was reached, at a meeting in London last week of the Railway Shopmen's Council, on the claim of the trade unions for an increase of wages. Adult males are to receive an addition of 4*s*. a week and adult females an addition of 3*s*. a week and juniors are to receive proportionate increases. The agreement is to have effect as from January 6.

Mr. Hicks, the Parliamentary Secretary to the Ministry of Works and Buildings, stated in the course of a broadcast talk last week, that new conditions were coming in the building industry which were vitally necessary to ensure victory. One change was the application of a modified form of the Essential Work Order which would mean, in effect, that building men must remain building men. The industry had been greatly weakened, he said, since the beginning of the war by the claims of the fighting Services and the usual wastage, and they could not afford to lose a single hour of building labour from now onward. The new conditions were a war-time measure. Sympathy was felt for the men in the industry and every effort was being made on their behalf. Mr. Hicks added that there might soon be a call for volunteers for a large mobile corps of building workers who could be moved about the country as required. Part of their work would be the repair of houses.

The resolutions adopted at the annual conference of the Bank Officers' Guild included one instructing the executive to use all possible influence to bring about legislation making company unions illegal. A resolution on the subject has been sent up, or is about to be sent up, by the Guild for discussion at this year's Trade Union Congress.

An agreement, to which the unions of Shop Assistants and Distributive Workers and the associated employers of their members in London are parties, provides for an increase of 3*s*. a week in the wages of workers of 22 years and over and an increase of 2*s*. a week in those of workers under 22 years in certain shops and large stores. Under the new arrangements, the highest minimum rate for men is 69*s*. a week and that for women 45*s*. The agreement comes into force at once.

Addressing the annual conference of the Labour Party as fraternal delegate, Mr. George Gibson, president of the Trades Union Congress, said that there was a sinister campaign in the Press which aimed apparently at a tapering of trade union conditions. It might be, he continued, that the country would reach a stage in its economy when greater sacrifices were called for. It that time came, the working people, who had already shown that they were willing to make sacrifices, would not be behindhand. "But," Mr. Gibson declared, "there will be no wage cutting unless there are limited dividends and sacrifices at the other end."

As a result of the further negotiations between the colliery owners and the Mineworkers' Federation, agreement has been reached on the subject of the conditions governing the payment of the attendance bonus of 1*s*. a shift. Some relaxation of the conditions has been effected. The causes of absence which do not disqualify for the bonus include accidents or after-treatment not obtainable outside working hours; sickness attended by a doctor on the day of absence; trade union work as an official delegate; attendance at local authority meetings held during working hours; obligations for civil defence work which enforce absence from the pit. Cases of hardship among aged or infirm workers are to have consideration.

Speaking on Friday last after the new agreement had been reached, Mr. Lawther, the president of the Mineworkers' Federation, said that the executive realised the enormous importance of increased coal supplies. "We can assure the nation," he added, "that the executive and the local miners' leaders will be in the vanguard of the drive for every ton of coal that is required. This settlement will help to that end, as the bonus is for those who work regularly and it meets all the miners' requirements."

The Minister of Labour and National Service has appointed Mr. G. B. Ince to fill a new post of Director-General of Man Power. Mr. Ince, it was stated, will take charge of the National Service, Labour Supply and Military Recruiting Departments of the Ministry. Sir William Beveridge is to relinquish the charge of the National Service and Military Recruiting Departments and to act as chairman of a committee—which will also include Sir Charles Craven, president of the British Employers' Confederation and Mr. J. C. Little, an ex-president of the Amalgamated Engineering Union—to examine, in consultation with the three Service Departments, the employment of skilled men in the Forces.

In the April issue of the International Labour Office's *Review* it is stated that under a Decree of December 19, 1940, all the corporations of workers, salaried employees and handicraftsmen which were set up in Roumania by the Act of October 11, 1938, were suppressed. Their property was transferred to boards, composed in each area of the regional inspector-in-chief, the president of the local chamber of labour and the general administrator, and is to be administered by the chambers of labour, but must be kept separate from any other property entrusted to the chambers for administration. The corporations which have been dissolved are not allowed to engage in any kind of activity. A breach of this prohibition will render the members of the former organisations liable to imprisonment for from six months to two years.

In an explanatory memorandum attached to the Decree, the Minister of Labour declared that the corporations had to be suppressed, because they did not confine their activities to the study, protection and development of their purely occupational interests. He added that the right of association for trade purposes would be placed on a new basis by a Legislative Decree to be issued later.

Under an Act of October 16, 1940, the Federation of Public Employees' Unions affiliated to the French General Confederation of Labour was dissolved and new regulations were issued concerning the right of association of public employees. Any group of public employees which is formed in contravention of these regulations, or whose activities are contrary to the national interest or foreign to the aims of the new association, will be dissolved by Decree. The disposal of its property will be in accordance with the provisions of the law governing associations. The leaders and members of groups which have been dissolved will be liable to a fine of from 500 to 10,000 francs or imprisonment for from six months to five years, or both penalties. Leaders of associations whose activities have been found contrary to public order, or the national interest, may have their authorisation withdrawn.

According to a Melbourne newspaper, the Australian Commonwealth Government has decided to introduce a scheme of child endowment for wage earners with substantial family obligations. The proposed scheme provides for an allowance at the rate of 5*s*. a week for each child after the first. Shortly before this decision was taken, the Minister of Education of Victoria had publicly expressed himself as in favour of raising the school-leaving age from 14 to 15 years if child endowment were introduced. The desirability of raising the school-leaving age was also stressed at the annual conference of the Australian Teachers' Federation in January, and also at the first "National Fitness Camp" at Dromana which was attended by delegates from municipalities and shires throughout Victoria.

A well-known American writer recently expressed the opinion that while "the vast number" of United States workers were loyal and patriotic and did not wish to see defence work interrupted, they permitted "the use of concerted action at any time and for any reason by a few men who control the local unions." The editor of the *Journal* of the International Association of Machinists—which is the equivalent in the United States and Canada of our Amalgamated Engineering Union—challenges him to name any American union "whose leaders can order its members on strike without the consent of those involved." "The International Association of Machinists," he says, "has entered into agreements with more than 5,000 employers, not including the railroads. Only a few of its members are on strike, and none of them against firms having defence contracts. No official of the I.A. of M. can call a strike . . . Furthermore, no strike of its members can . . . be sanctioned until every effort to adjust grievances has been exhausted, and even then, except in case of extreme urgency, it requires a three-fourths vote by secret ballot of those involved and qualified to vote to declare a strike."

The editor of the *Journal* goes on to quote declarations by witnesses before the House Justiciary Committee at Washington to the effect that strikes had caused no important delays in the defence programme. They blamed the newspapers for "playing up labour controversies to a point where the average man gets the impression that strikes are sweeping the nation." "That is simply not true," said one; "strikes are rare exceptions in the defence industries, and responsible labour leaders are doing everything possible to avoid interruption of production."

THE ANNIS METER.*

By M. B. MACNEILLE and RUSSELL K. ANNIS.

CONSIDERING that so many accurate and well-tried flowmeters are already in use, it seems fitting to explain the reason for developing yet another type. The problem first arose in connection with measuring the rate of flow in propeller pumps, such as that shown in Fig. 1, herewith. These propeller pumps had very short suction and discharge pipes, consisting only of cone-shaped conduits bolted directly to the suction and discharge flanges of the pump. This arrangement did not allow sufficient distance for the installation of a Venturi meter, which in any event would have been expensive, as these pumps were quite large in size. Current meters had been considered, but were not used because of the irregular shape of the channels. Pitot tubes were used on a number of occasions, and were moderately satisfactory, but the accuracy was not great on account of the irregularity of the readings, and they required too much time for the traversing of a large pipe. Weirs were also tried, but they are too costly, especially when used only once on location and then removed. The salt-water method and the Gibson method were considered, but both of these methods require long pipes and for this reason were not usable.

The first intake meter was, therefore, improvised by using the suction cone of the propeller pump, as shown in Fig. 1. Since the suction conduit of the pump has convergent flow, exactly the same as a Venturi tube, the same transformation of energy occurs. There is, however, no straight pipe leading to the intake meter, such as required by a Venturi tube. The manometer hose is simply submerged in the open channel. This acts as a balance tube. The throat section at the flange of the pump, in Fig. 1, acts in a manner similar to the throat of a Venturi tube.

In some instances, a piezometer ring has been used at the throat, and in others, just a single side hole. Also, it has been found to be immaterial whether the meter connects directly into the pump suction as shown, or whether a suction pipe is used between the meter and the pump. With the intake meter, there is ordinarily no exit cone beyond the throat, because the throat is usually the same diameter as the suction pipe and no cone or diffuser is needed. There are occasions when a meter throat smaller than the suction pipe is used. Under such a condition, an exit cone is required. An exit cone, however, is known to have no influence upon the operation of a Venturi meter and the question of its omission is, therefore, of no consequence.

The intake meter has the following advantages over other fluid meters:—(1) The intake meter does not require an upstream section of pipe. (2) No exit tube is required, such as is ordinarily used in connection with Venturi tubes. (3) There is no loss of head, such as occurs in the downstream pipe beyond an orifice or nozzle. (4) There is no entrainment of air in the suction bay, such as occurs when testing pumps in a test tank using a weir, or an open nozzle, or orifices on the end of the discharge pipe, which are allowed to discharge their jets into the open surface of the discharge bay. (5) The meter is not expensive to build or install. (6) The readings are instantaneous.

Figs. 2 and 3, on this page, show diagrammatically the principle upon which the theory of operation is based. The meter consists of a straight cylindrical section which is surrounded by piezometer holes exactly like the throat section of a Venturi tube. Leading into this section there is a tapered section, which is rounded off at the large end in order to provide an easy flow for the water entering the meter from the suction bay. A generous radius is also provided between the small end of the tapered section and the throat. Intake meters have been built up from sheet metal without these radii, however, and satisfactory results were obtained.

An inverted U-tube manometer is shown at approximately the same elevation as the pump. A rubber tube *a* is connected to one side of the manometer, and the lower end of this tube is submerged in the suction bay. Tube *b* is connected from the other side of the manometer into the piezometer throat of the intake meter. A connection *c* is made at the top of the manometer for the purpose of withdrawing a certain amount of air, thus raising the water within the manometer to an elevation which will be convenient for making readings. Let us assume first that there is no flow in the intake meter, and that an amount of air has been drawn from connection *c*, sufficient to raise the water in side *a* to a height represented by $H_{a\text{-}zero}$ above the surface of the water in the suction bay. Since there is no flow, it follows that the water in side *b* will also rise to the same elevation as in side *a*. This is indicated by the dotted line. Side *a* thus acts as a balance tube to compensate for the difference between atmospheric pressure at the surface of the suction bay and the partial vacuum existing within the U-tube.

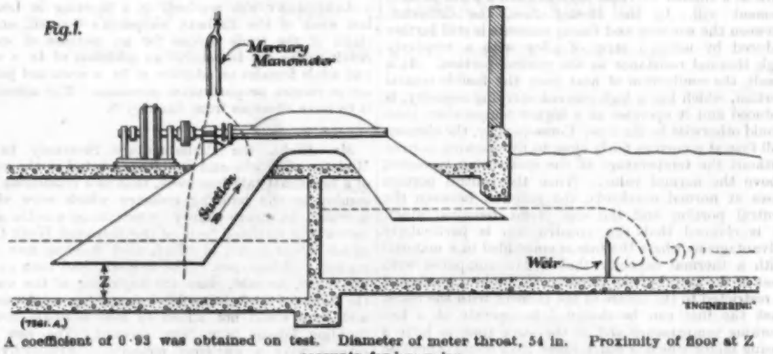
Now assume that there is a flow of V cub. ft. per second into the intake meter, producing a velocity S ft. per second at the piezometer throat, which has a sectional area of A sq. ft. Also assume that, while this flow is taking place, the amount of air withdrawn from connection *c* is sufficient to draw the water in side *a* up to any convenient height represented by H_{aq}. Thus, if H_{bar} represents the atmospheric pressure measured in feet of water above the surface of the suction bay, the absolute pressure at the water surfaces in both sides of the manometer is

$$H_a = H_{bar} - H_{aq}.$$

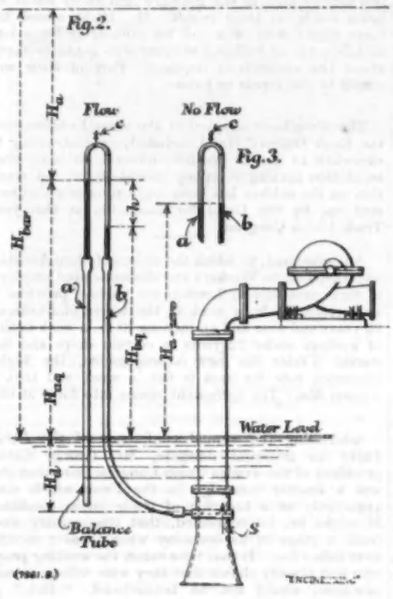
When there is continuous flow from the suction bay into the intake meter, the total dynamic head in the suction bay and at the elevation of the piezometer, according to Bernoulli's theorem, is equal to the total

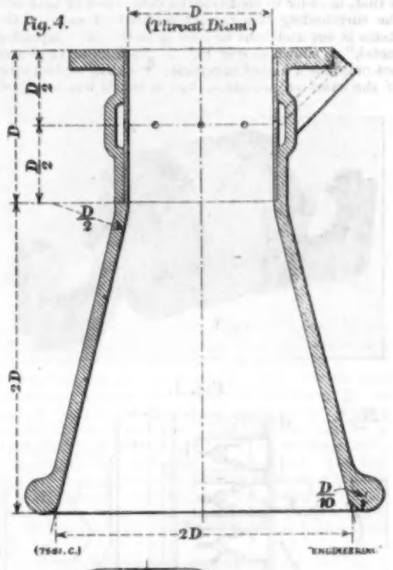
* Paper presented by the Special Research Committee on Fluid Meters at the annual meeting of the American Society of Mechanical Engineers, New York, December, 1940. Abridged.

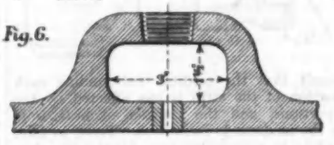
THE ANNIS METER.

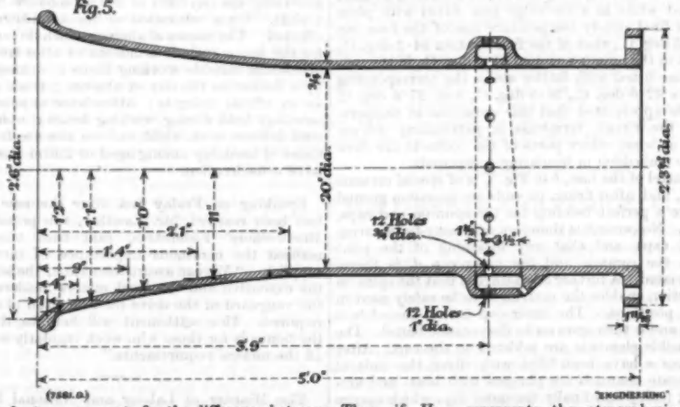


A coefficient of 0·93 was obtained on test. Diameter of meter throat, 54 in. Proximity of floor at Z accounts for low value.









THE ANNIS METER.

Fig. 7.

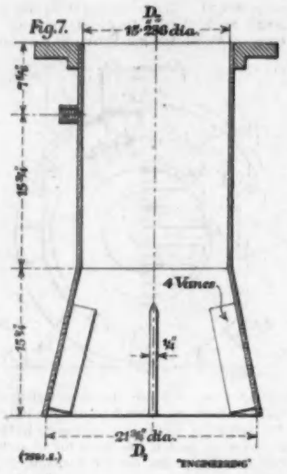


Fig. 8.

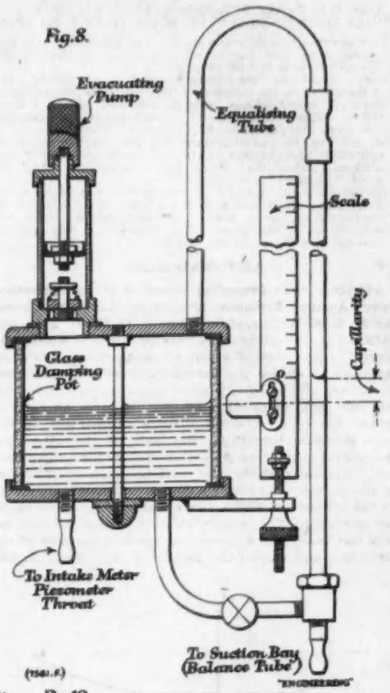


Fig. 9.

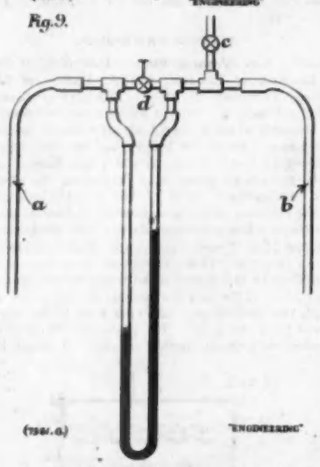


Fig. 10.

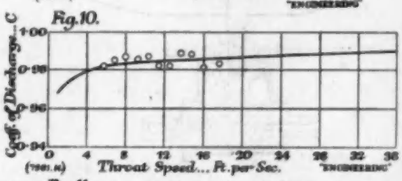
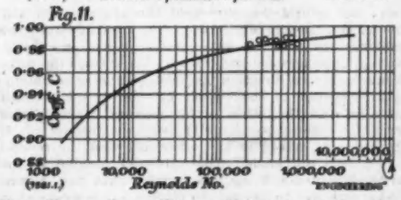


Fig. 11.



dynamic head inside the intake meter, also at the elevation of the piezometer, plus any losses H_f due to friction or any other causes.

Thus,

$$H_{aq} + H_a + H_d = H_a + H_{bq} + H_d + \frac{S^2}{2g} + H_f.$$

It is assumed that both the velocity and the friction of flow in the suction bay are so small that they are negligible. This will always be the case if the meter is installed at those distances from the floor and walls which are recommended later in the paper.

Therefore,

$$H_{aq} - H_{bq} = \left(\frac{S^2}{2g}\right) + H_f;$$

but

$$H_{aq} - H_{bq} = h,$$

hence

$$h = \left(\frac{S^2}{2g}\right) + H_f.$$

Now, let

$$C = \sqrt{\frac{\frac{S^2}{2g}}{\left(\frac{S^2}{2g}\right) + H_f}};$$

then

$$S = C\sqrt{2gh},$$

and so

$$V = CA\sqrt{2gh}.$$

A curve of values of C is given in Fig. 11, on this page.

Fig. 4, opposite, shows general proportions for the construction of meters of any size. The 6-in. meter was constructed in accordance with these dimensions. Dimensions for the 20-in. meter are shown in Figs. 5 and 6, opposite. Other sizes have also been built, including both the 15-in. and the 24-in. sizes, of welded construction. The 15-in. size is shown in Fig. 7, on this page. A calibration test on this size of meter showed a coefficient of 0·967 ± 0·5 per cent. for an average of four readings at approximately 1,200 000 Reynolds number. This coefficient is smaller than obtained on 6-in. size, because of high ratio of D_2 to D_1, and also because of abrupt entrance at D_1.

The manometer is shown in Fig. 8, on this page. This manometer has a glass tube and scale. The lower end of this tube is connected into a Tee connection, one branch of which leads out through a hose nipple into the balance tube, which is submerged in the suction bay. The other branch of the Tee connects through a by-pass pipe and valve into the bottom of a damping pot. This by-pass valve is normally kept closed. A small evacuating pump is fastened to the top of the damping pot. This pump is used for removing air from the manometer, thus drawing water up from the suction bay. It is made comparatively small so that it is not possible for the operator to fill the tubes too quickly and entrain air bubbles along with the water. As soon as the water is raised to the desired level, the plunger is screwed down against a gasket, which seals the pump against any possible leakage through the valves. The upper end of the glass water-column tube communicates with the top of the damping pot through an equalising tube which causes the absolute pressure at the surface of the water in the pot to be equal to the absolute pressure at the reading of the water column. The bottom of the damping pot is connected to the piezometer throat by means of a rubber hose.

Since there is a differential head on the manometer whenever there is a flow of water in the intake meter, there is also a flow of water up from the suction bay, through the by-pass pipe, and down into the intake-meter piezometer, provided, of course, that the by-pass valve is open. This flow through the connecting hose flushes out any air bubbles which might be trapped at any point. It has been found to be a good practice to open and close this valve before each reading.

On account of the effect of capillarity, the water column in the glass tube at zero flow will evidently stand at a slightly higher elevation than the water level in the damping pot. This is corrected by adjusting the zero for the scale just enough above the damping-pot pointer to compensate for this capillarity. The scale has a vertical adjustment which is raised or lowered for each reading until the damping-pot pointer is exactly in line with the level of the water in the damping pot. Fig. 9, on this page, shows the arrangement of a mercury manometer which has been used for higher readings than are convenient for the water manometer. A micromanometer is useful for very small readings of, say, 1 in. or less of water.

Five different sizes of intake meters have been built and calibrated. The earlier tests were less accurate than the more recent ones; experience has been gained as the different meters have been built. Because of the experience gained on other sizes and also because the 6-in. size is the smallest and easiest to handle, it is the one which was calibrated most accurately and which shows the greatest uniformity of coefficients over a wide range of velocities. Fig. 10 shows the results of this calibration in the form of a curve plotted against velocities, and Fig. 11 shows the same results plotted against Reynolds numbers. In both cases, the water is at 60 deg. F.

The tests for the 6-in. meter were made by calibrating the readings against flow nozzles of the jet type. These nozzles were screwed to the end of a brass tube having an internal diameter of 7·75 in. and having a piezometer ring for measuring the static head. These nozzles had previously been calibrated against direct measurements of water; therefore, any inaccuracies of the calibration include the inaccuracies of the 3-in. and 5-in. flow nozzles which were used. The results of this calibration are of a high degree of accuracy, and are at least as accurate as existing tests of Venturi meters. There is every reason to believe that, with a calibrated instrument of this type, the accuracy depends only upon the degree of fineness to which the manometer can be read. In the present instance, the 11 points all fall within less than ±0·5 per cent. of the accepted Venturi-meter curve.

No difficulties with cavitation have been encountered in any of the intake meters tested. Nevertheless, cavitation is a theoretical possibility and should be avoided. The conditions causing cavitation are too well known to require any very extensive discussion here. It is sufficient to say that throat velocities should be kept below the critical value for the pressure and temperature of the liquid being metered. With water at ordinary temperatures, any velocity under 30 ft. per second is certainly safe, and this can probably be exceeded without difficulty. Ordinarily, however, throat velocities are considerably below this. The fact that the meter is submerged below the surface of the water gives additional protection, as this positive head adds to the total pressure on the liquid. The manometer is always located at as low an elevation as convenient, because the suction on the manometer is greater than on the meter, due to the difference in elevation. For this reason, cavitation would probably indicate its presence in the form of air bubbles in the manometer before any ill effects would occur within the meter itself.

It is ordinarily recommended that the diameter of the meter throat be the same as the diameter of the suction pipe. When this condition is met, the meter does not increase the total suction lift on the pump. In fact, the total suction lift, when using a meter of the same diameter as the suction pipe, is actually less than the total suction lift without the meter. This is due to the entrance loss which occurs when an open-ended pipe is used; this loss is eliminated because of the enlarged entrance and easy flow into the meter. Intake meters with throats smaller than the suction pipe have been successfully used, and are perfectly permissible. Throat velocities, however, are higher when this is done, and cavitation might possibly occur, especially if the throat diameter is made too small in proportion to the pipe diameter. It is considered best, therefore, for the diameters to be made approximately equal.

For a design having the highest coefficient, intake meters should be designed in accordance with Fig. 4. This gives the lowest intake loss. The intake loss for any of the meters tested, however, was negligible. A meter should be selected, the throat diameter of which is approximately equal to the diameter of the suction pipe. The manometer should be installed at an elevation not too high above the surface of the water, as this causes the extraction of dissolved air. The meter should be installed not closer than one throat diameter from the floor. Locating the meter close to the side walls of the suction tank has been found to have no measurable effect upon the accuracy.

The coefficients, as plotted in Fig. 11, are applicable to any size of meter, velocity and viscosity. The test

points have been taken from tests only on the 6-in. meter with water, and the curve has been drawn in from the standard A.S.M.E. Fluid Meter Report. Points above a Reynolds number of 100,000, which will include almost any application for measuring water, are highly accurate. At smaller Reynolds numbers, the curve is only presumptive until calibration tests with air can be carried out.

Rubber-hose connections should be as short as possible, and should slope upward toward the manometer, in order to bring to the surface any air bubbles which might form. Hose having an internal diameter of ¼ in. or larger is preferable. All connections must be absolutely tight. On account of the necessity for keeping the connecting hose lines open for the conduction and detection of air bubbles, it is best not to try to steady the manometer readings by throttling. Steady manometer readings can be obtained by submerging the lower end of the balance tube within a pail or other convenient enclosure. If the pail is suspended to such an elevation that the brim is just above the surface of the water, and a small hole is punched in the bottom, extremely steady readings will result.

The accuracy to be expected from any one reading is ±0·5 per cent., provided all of the foregoing precautions are taken, and provided a manometer is used suitable for readings of this accuracy. Greater accuracy is obtained if several readings are averaged. This procedure is for ordinary commercial use. With a specially calibrated meter, and using a highly sensitive micromanometer, there is probably no limit to the accuracy obtainable.

DEPOSITS OF TUNGSTEN AND ANTIMONY IN IDAHO.

A DEPOSIT of high-grade tungsten ore has been discovered, as the result of joint exploration work by engineers of the United States Bureau of Mines and geologists of the Geological Survey, in the Yellow Pine District of Valley County, Idaho. This district is well known for its antimonial gold ores but was not previously known to contain tungsten ores. The magnitude of the ore deposit has not yet been determined, but it appears that sufficient information has been obtained to indicate that the discovery may be one of great importance. The investigation of the ore deposits of Central Idaho has been in progress for the past eighteen months and the Bureau of Mines has carried on extensive surface trenching and diamond drilling in this area. Recently, in examining the material on some of the diamond-drill cores it was discovered that the tungsten mineral scheelite was present, and the re-examination of earlier samples indicated a widespread distribution of the mineral. Although the assaying of the ores has not yet been completed and diamond drilling is still being continued, it has been found that scheelite ore of commercial grade has been encountered in four holes drilled in a piece of ground upwards of 100 yards in length. Further, the depth of the strata has been shown to range from 5 ft. to 25 ft., and several of the 5-ft. sections have assayed over 5 per cent. of tungsten trioxide. It is stated that ore deposits containing as little as 0·75 per cent. of the trioxide, if fairly extensive, are generally considered as being of commercial grade, hence the present deposit, if large, will form a notable addition to the country's mineral resources. In addition to constituting one of the principal elements in high-speed steels, ferrous alloys containing smaller amounts of tungsten are used for a wide range of industrial products and military equipment such as projectiles, ordnance and armour plate.

The presence of large reserves of antimony ore in Central Idaho has also been ascertained. This element is used in the manufacture of bullets and shrapnel, and is also one of the ingredients present in type and bearing metals. Both tungsten and antimony are quoted in the list of the United States Army and Navy Munitions Board as "strategic" materials, and the fact that much of that country's supplies of these two elements has hitherto been imported from China lends added importance to the results of the investigations at present in progress in Idaho.

THE APPLICATION OF ROPES.—The editor of the illustrated house journal *Rope Talks*, which deals with the application of the various products made by British Ropes, Limited, informs us that some of the mailing lists have been destroyed by enemy action. Any of our readers who have hitherto received a copy and have not had No. 16 of the series are requested to notify him, at Messrs. British Ropes, Limited, Anchor and Hope-lane, Charlton, London, S.E.7, so that their names may be restored to the mailing list.

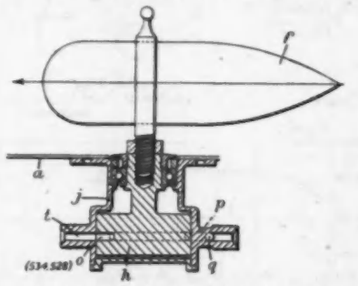
"ENGINEERING" ILLUSTRATED PATENT RECORD.

ABSTRACTS OF SPECIFICATIONS RECENTLY PUBLISHED UNDER THE ACTS OF 1907 TO 1939.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned, the Specification is not illustrated.
Where inventions are communicated from abroad, the Names, etc., of the Communicators are given in italics.
Copies of Specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery-lane, London, W.C.2, price 1s. each.
The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.
Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

AERONAUTICS.

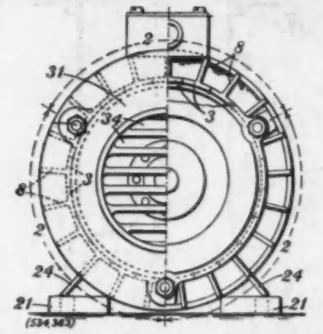
534,528. Pitch Control of Contra-Rotating Airscrews. Fairey Aviation Company, Limited, of Hayes, Middlesex, and M. E. A. Wright, of Stanmore. (12 *Figs.*) July, 25, 1939.—The invention is a device for the automatic control of the pitch of a pair of contra-rotating co-axial airscrews to ensure the maintenance of a non-rotating slipstream. The variable-pitch airscrews are driven by separate but identical engines. On the aircraft is mounted a vane *f* pivoted about a vertical axis in the vertical plane containing the axis of the airscrews. Deflections of the vane *f* due to rotation of the slipstream are communicated to the variable-pitch mechanisms of the airscrews through a valve or switch, according to the system on which the variable-pitch mechanisms are operated. The rotary valve A shown is mounted in a ball bearing in a casing *j* secured to the skin of the aircraft *a* and carries the spindle of the vane. In the



valve are formed two divergent through passages and an exhaust passage while the casing *j* has a bifurcated inlet passage *p*, *q*, two outlet passages, and an exhaust passage *t*, the arrangement being such that when the valve is moved in one direction the inlet passage *p* communicates with one of the outlets via one of the through passages and the other outlet passage communicates with the exhaust passage *t* through the passage *o*. If the valve is moved in the other direction the reverse connections are made. The valve is mounted in the hydraulic circuits of the two variable-pitch mechanisms and is arranged to control the pitches of the airscrews in such a way as to maintain a non-rotating slipstream. Over-riding pilot's controls can be provided if desired, so that the pilot can select the values of the airscrew pitches at will, but these over-riding controls would normally be biased to the neutral position in which the automatic vane control alone is operative. (*Accepted March* 10, 1941.)

ELECTRICAL APPARATUS.

534,383. Electric Motor. W. Scott, of London. (5 *Figs.*) February 16, 1940.—The invention is a fabricated barrel or carcase for a motor or dynamo which is cheaper to produce than the cast type of barrel. The barrel of the motor consists of a number of sections 2, each built up from lengths 3 of T-section iron cut from standard stock. These lengths 3 are first mounted in a jig, in which the cross-piece of the T-section is pressed to the curvature of the barrel. When the requisite number of lengths 3 have been so pressed they are mounted in a jig with their longitudinal edges abutting so that they form a continuous part-cylindrical section, while their webs 8 project outwards to form cooling fins. The jig is then transferred to a welding bench, where the lengths are welded either on the inside or the outside. The welds extend a short distance inwards from the ends, leaving a plain central portion to receive the stator core stampings. The stator core stampings are assembled into a pack and secured together. The required number of barrel sections 2 is then mounted round the outside of the pack and clamped tightly in position by a ring clamp, after which the seams between the sections are welded. The assembly is then machined on the inside at each end to form peripheral seatings for locating spigots on the end-plates. The contraction of the welds firmly clamps the laminated stator core in position and ensures good heat conduction from the stator to the cooling fins. Base plates 21, drilled for fixing bolts, are welded along their inner edges to certain fins, and supporting stays 24 are butt-welded to other fins 8 and to the top surfaces of the base plates 21. The outer cover 31 has inlets 34, and its periphery is shaped to direct air from the fan over the barrel between the fins 8. By the use of welded



joints the lengths of stock are drawn so tightly together during cooling that a substantially air-tight casing results. No particular accuracy is necessary in the fitting of the end cover 31, and it has been found sufficient to rely on the securing bolts for its location. (*Accepted March* 5, 1941.)

MISCELLANEOUS.

526,811. Gas-Washing Plant. International Corporation, Limited, of London, and A. Ryner, of London. (3 *Figs.*) February 23, 1939.—The plant consists of a tower 1 having a gas inlet 2 leading into a lower chamber 3 beneath which a deep body of water is maintained in the sump. From the lower chamber the gases pass out through a body of washing water maintained between the two perforated plates 6, 7 supported one above the other. As shown in Fig 2, the perforations in each plate are rounded, since this allows of the use of comparatively thick self-supporting plates. The perforations of the upper plate 7 are smaller and closer together than those in the lower plate, the total cross-section of the perforations in the upper plate being larger than in the lower plate. If the fan is stopped, all the water escapes through the perforations, carrying with it the impurities removed from the gases. The plates can thus be cleared of impurities without further trouble. A slight head of

Fig. 1.

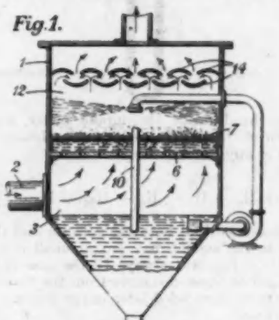
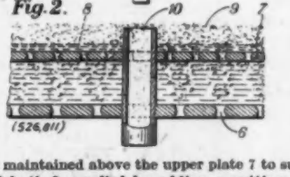


Fig. 2.



water 8 is maintained above the upper plate 7 to support a layer of froth 9 supplied by adding a wetting agent. The maximum level of the water 8 above the plate 7 is determined by an overflow 10. The water, with the oil for creating the froth, is returned by a pump to the upper chamber 12, where it is sprayed over the upper plate 7 in the form of a horizontal spray. Baffles 14 near the top of the tower trap any moisture in the gases before they pass to the outlet. In operation, the sprayed water fills the space between the plates 6, 7 and this space is maintained full by the pressure of the gases in the lower chamber 3. By the use of two plates, one of which has a different size and number of perforations from the other, the water can be prevented from being forced entirely above the top plate and the velocity of the gases is reduced inside the space between the two plates so that the gases are effectively cleaned. (*Accepted September* 26, 1940.)